The Welding Engineer

Edited by L. B. Mackenzie

$3.00 per year in U. S. | Reg. U. S. Pat. Office | $4.00 per year abroad

Vol. 8 | 608 S. Dearborn St. | JANUARY, 1923 | Chicago, Ill. | No. 1

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Published Monthly by the Welding Engineer Publishing Co. Entered as Second Class Matter Jan. 20, 1916, at the Post Office at Chicago, Ill., Under the Act of March 3, 1879.

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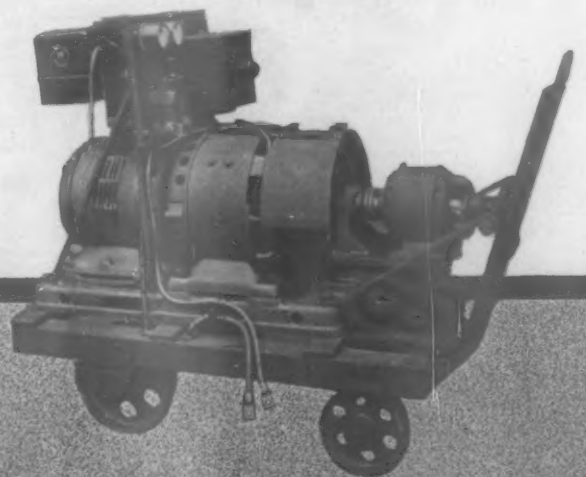

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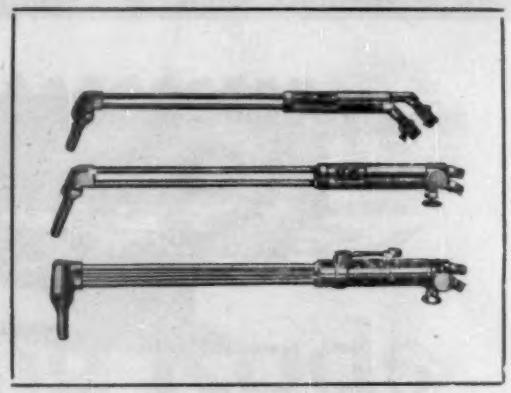

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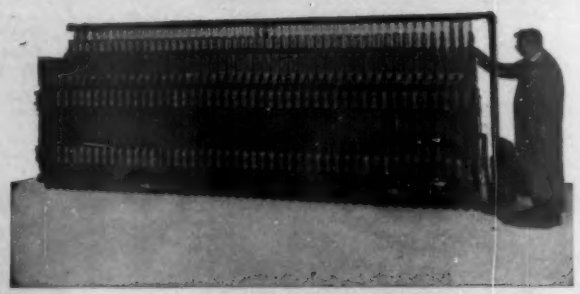

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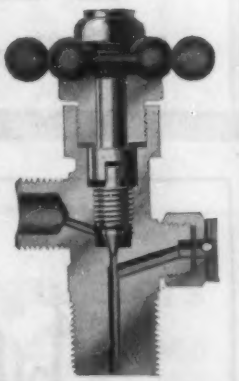

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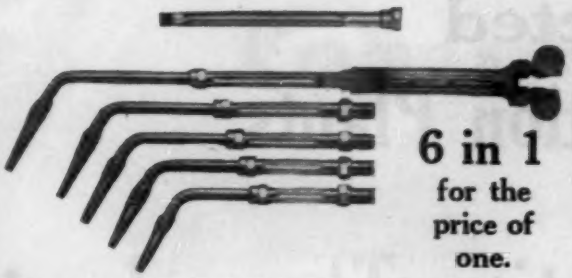

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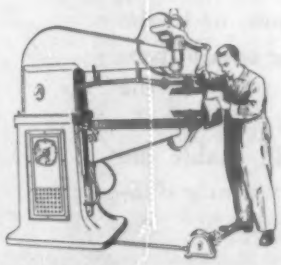

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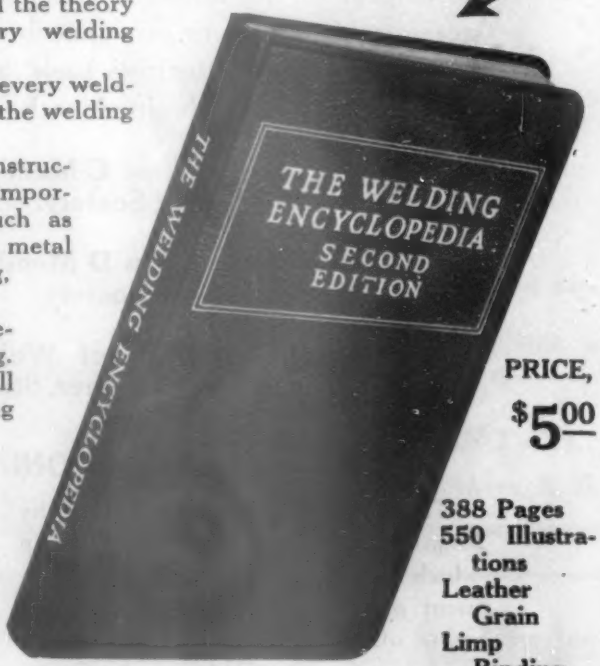

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3rd Prize: Copy of Welding Encyclopedia bound in Leather, Stamped with Owner's Name.

CONDITIONS

There is no restriction as to the length of this story, or the time in which the work is done. The assignment of prizes will be based on the value of the story as a whole to the readers of The Welding Engineer. Manuscript does not have to be typewritten, and it will not be judged upon its literary merits. If sketches are necessary to illustrate any features of the work, you need not submit finished drawings. Pencil sketches will serve the purpose just as well. One point to be kept in mind is that the story ***should be complete enough to enable another welder to do the same job after reading it.*** There is no restriction regarding the nature of the work described. It may be either production work or repair work. It may be oxy-acetylene welding, electric arc welding or thermit welding. The value of the story may consist entirely of a description of the method of preheating in the case of a repair job, or in the construction of a jig in the case of production work. The purpose of the contest is to bring out practical working instructions which will enable the other fellow to do a particularly difficult piece of work.

In case manuscripts are received which are considered good information for our readers, but which are not quite so good as the stories which are winners in the prize contest, they may be printed in The Welding Engineer, in which case the story will be paid for at our regular rates.

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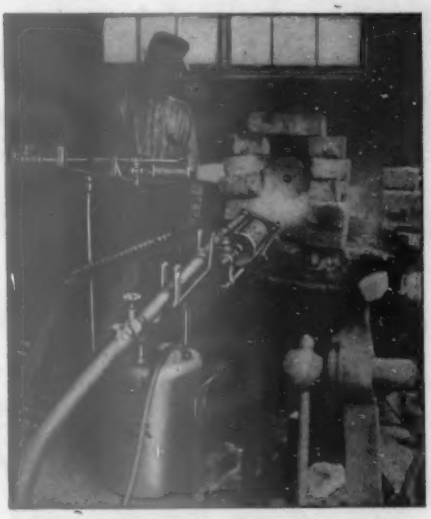

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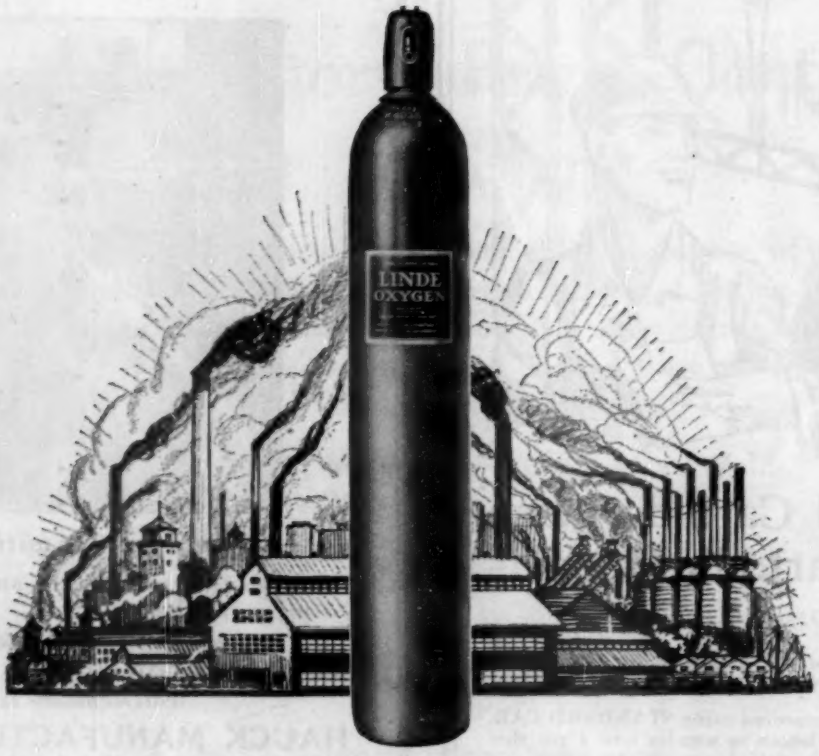

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An All Welded Steel Floor

How the Hershey Chocolate Company Solved the Problem of Sanitation and Maintenance

By H. H. Freysinger

THE applications of the electric arc are so unlimited that the writer when asked what he had to suggest as a good floor for a milk receiving room at once said; "A welded steel floor; what else would you expect a welder to say?"

The next question was, "Can it be done?" The reply was, "Why can't it be done?" And next came, "Just how would you do it?"

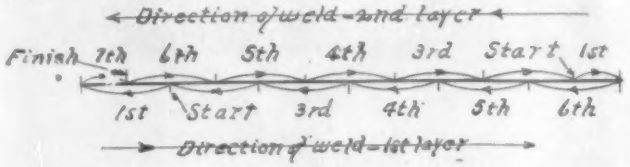


Fig. 1

Direction of Welding.

And right there is where I started to think seriously about why it could or could not be done.

As the building was just in the broken ground stage, all details had to be worked out from floor plan drawings furnished by the firm doing the concrete work. These plans called for a reinforced concrete structure with no steel beams to anchor the plate to and no way of aligning plates by mechanical means such as bolts or clamps, as is customary.

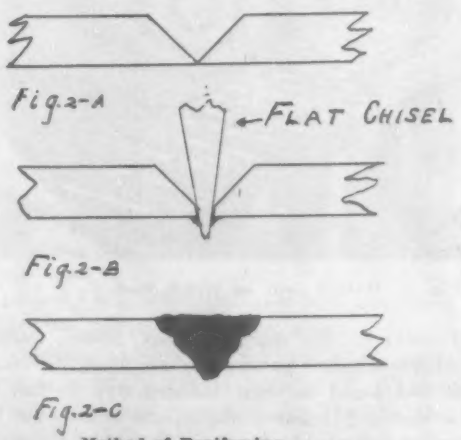
The floor in question was the second. The pasteurizing and clarifying room was on the first. Anyone who knows milk knows that when it is good it is very good; and when it gets under a floor or something during warm weather it gets worse than bad, judging from the odors given off.

Heretofore cement and bituminous flooring were used with more or less leaking and a great tendency to crack and wear through at the points of greatest use. Bear in mind that about 300,000 lbs. of milk enter this room daily, mostly in 100 lb. cans. This gives some idea of the wear on a floor for this purpose.

Sanitation is a greater problem than wear. Summed up the floor had to be 100 per cent waterproof and have as great a resistance to shock and abrasions as possible. Steel plate was the only material which could be depended upon to meet these requirements and a sand cushion on the concrete was recommended, to deaden the noise produced by moving cans.

The plates were ordered cut 4 ft. x 10 ft. x 3/8 in. planed to a 45 deg. bevel, with this bevel running down to a sharp or knife edge. On delivery it was discovered that there were very few straight plates in the lot, the majority having waves in them. The rigid method of welding was adopted, using the step back system in 6-in. steps, filling the V two-thirds full the first layer and then cleaning with a stone cutter's pneumatic dressing tool for the second, which was applied in the opposite direction. (See Fig. 1.) By taking short steps and overlapping the sections of the first layer with those of the second the increment of the stresses was distributed thruout the entire length of the weld. A 3/16-in. electrode was used, keeping the current as low as was consistent with good welding. In other words, the operator's ability and judgment should tell him more than the meters on the machine, as he must have ample, but not excessive penetration with the shortest arc he can work, no "cold shuts" and a minimum of slag inclusions, to get the toughest weld with the least contraction possible on flat plate work.

There being little chance for reinforcing on top the scheme shown in Fig. 2 was tried out and found satisfactory in this case. The edges were turned down with a flat chisel in a pneumatic chipping hammer after the plate was tacked into position. While the weld was being made trucks loaded with sand-bags were placed on the plates to hold them down and prevent buckling along the line of weld. This proved very satisfactory as a



Method of Reinforcing

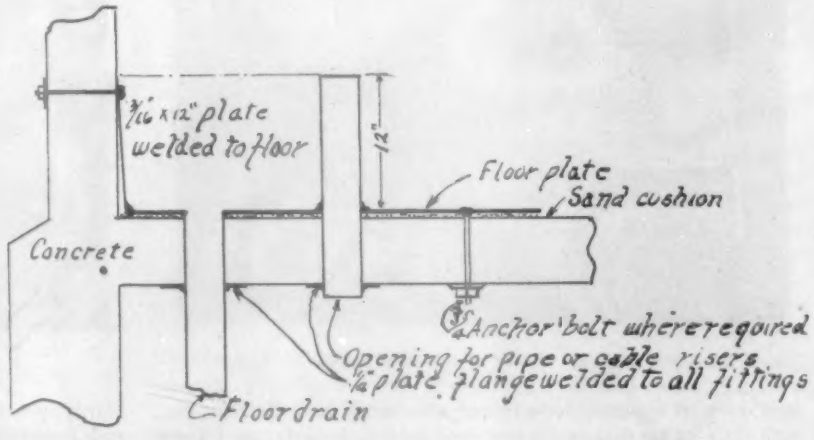


Fig. 3.

Details of Floor Construction.

temporary anchor. After all plates were welded, some spots had a tendency to bulge and interfere with drainage. By cutting a counter-sunk hole in the summit of the bulge and drilling thru the concrete, then placing a countersunk ¾-in. bolt thru both (see fig. 3) and drawing down to place we were able to get a good surface on the entire job.

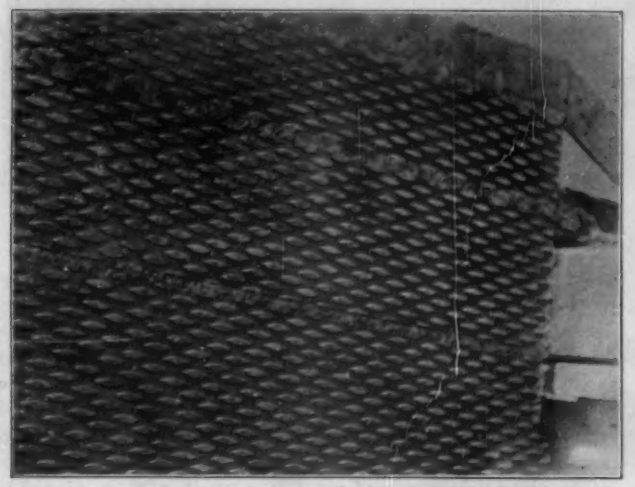


Fig. 4. Bumper Rail Welded to Floor Plate.

Fig. 3 shows cross section of the floor, illustrating how pipes were taken thru, drains attached, washboard welded to floor and bolted to walks and columns, sand cushion and anchor bolts.

When completed we had a flat bottom tank 0 ft. 12 in. deep, 64 ft. 0 in. long and 29 ft. 0 in. wide with a 12 ft. 0 in. by 13 ft. 0 in. wing at the one corner. All door frames were of steel, with washboard and floor plate welded to them. The total length of weld was approximately 875 linear ft. and to date there is no sign of a leak anywhere. No attempt was made at speed in welding on account of having a peculiar sort of job and not being able to get any data at that time (March, 1920), on flat plate work of so large an area (2,054 sq. ft.) without any underframe as a support. We took no chances on trying to keep labor costs down by speeding up the welding operation.

While prior to that time a great amount of deck work had

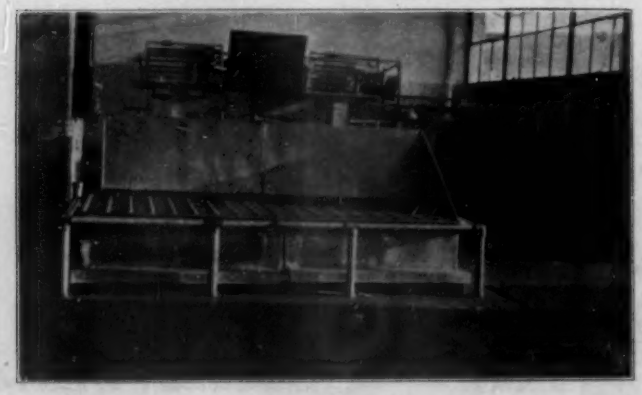


Fig. 5. One of the Weigh Tanks.

been done on sea-going vessels and some small tank bottoms, etc., with little or no data and experience published, so far as I knew at that time, I felt elated at having the opportunity to work out the details and overcome the difficulties always encountered on something new. While the method of handling the job is not new to many, nevertheless it goes to show that there is a place for welding in unthought of corners or places and ways that will effect great savings over old methods. For instance, this floor is worked with one man less due to the ability to slide or "shoot" cans over the smooth surface, netting a saving on labor alone of about $1,200.00 annually. Next to be considered the ease with which this floor can be repaired over that of a cement or bitumen covering, which always has a joint or weak point at the edge of each repair. These facts show that the seemingly high cost of the welded job shrinks to a small amount when sanitation, service and ease of repair are considered.

Fig. 4 shows a side of a doorway with bumper rail welded to floor plate. Note that scrap plate was used to fill in spaces not provided for in the original plans.

Fig. 5 shows one of two sets of weigh tanks with welded grating on top (pipe railing around same is welded to floor).

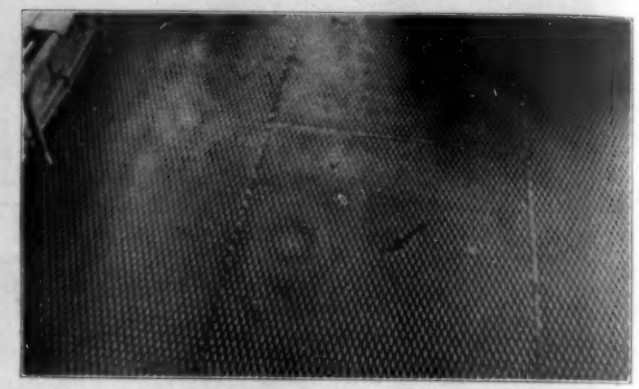


Fig. 6. Showing Anchor-Bolt in Center of Sheet.

Fig. 6 shows cross and longitudinal welds with anchor-bolt head near center of picture.

Note on Fig. 3 that the floor and splash plate were kept away from the walls at the bottom, allowing room for expansion of plate when being washed or flooded with boiling water to sterilize at the end of each day's work.

Owing to the nature of the product of this plant it was ofttimes necessary to produce a strictly sanitary article in the welding shop. Such jobs had to be pickled and tinned after welding which made it necessary to equip the shop with acid and tin baths. One new use for the carbon arc was "discovered."

In removing broken frames from candy moulds a great amount of trouble was experienced in getting the $\frac{1}{8}$ in. x $\frac{5}{8}$ in. steel stock of the frame hot enough to loosen the soldered joint between the frame and thin tin before the tin would discolor the

Fig. 7. Welded Grill on Weigh Tank.

highly polished surface. By using a $\frac{1}{16}$-in. carbon electrode and a current of 200 amperes passing the arc along the outside of the frame it was found the heat radiated thru so fast that it melted the solder and released the frame before the heat affected the polish of the mould. Another favorable characteristic was that the burning of the arc along the frame stock had a tendency to warp it away from the mould as fast as it loosened, making the operation a natural or automatic one and a great improvement over the gas flame and pinch bar formerly used, speeding the operation up about 75 per cent.

The possible applications of the torch and arc are so numerous and in the majority of cases so obvious in all lines of indus-

try that I am convinced by observation and experience that in the majority of cases the advances are entirely up to the operator. If he is on the job and knows his business, and is able to talk a little "horse sense" and convince the management that he ought to have a chance to demonstrate and produce, he surely can make himself a useful man around the place.

For instance I know of one firm that had a welding and cutting torch about two years and firmly believed they had not much use for it until they had occasion to employ an experienced welder. At the end of 6 months they gave him a helper, in 6 months more another helper and about a year later a third helper. Thus in about 2½ years they went from one man, one torch and little work, to 4 men, three 20-inch torches, one 36-inch water cooled torch two cutting torches and one arc machine.

Fig. 8. View of Welded Floor.

If the possibilities of welding had not been proven, without a doubt the welding department would have remained the same little corner in the machine shop and never could have been known as a division of the mechanical department.

Therefore, fellow welders, I say that it is up to us to take the knowledge given us by research work and our past experience in one hand and the "tools of the trade" in the other and *go to it.*

If we get stuck or don't know how, there is always a way of finding out, viz.; work it out or ask the trade for help. "Can't be done" is a useless fellow around the welding shop, don't take him seriously.

TEMPERING SAWS WITH OXY-ACETYLENE

Illustrating Value of the Oxy-Acetylene Process for Heating

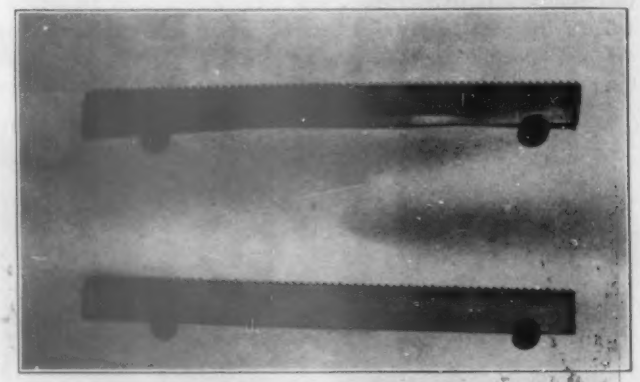
Perhaps no oxy-acetylene application other than welding and cutting has revolutionized a manufacturing practice to a greater extent than has occurred in the tempering of hack-saws and band-saws used for cutting metals. These saws must have a hard cutting edge, while the body of the blade should be relatively soft and ductile. The old method of tempering the saws was to pass them through a slot in a water-cooled cast-iron block, above which only the teeth of the saw would project. Jets of flame were directed against each side of the saw until the upper part was brought to a tempering heat, when the saw was quenched in oil. Compressed air and city gas were used.

Production by this process was slow, due to the fact that the saws would not heat sufficiently if fed rapidly through the slot. Another objection was the fact that the heat was conducted into the body, resulting in the tempering of a considerable portion of that part of the saw which should be ductile. The blades frequently failed in service due to breaking, cracking, bowing at the center or warping sideways. To prevent the hack-saws from breaking when clamped into the holder, it was necessary to reanneal the blades.

These difficulties have been removed by the use of the oxy-acetylene flame for tempering, and the product has been very much improved in other ways. Instead of tempering approximately half of the blade, which was unavoidable by the old process, oxy-acetylene makes it possible to confine the tempering to the teeth and to produce a soft-bodied saw that is practically free from flaws.

Using the oxy-acetylene process, one machine does the work that four machines would formerly do. Moreover, the oxy-acetylene machine is semi-automatic in operation, requiring only periodic attention of one operative, as against the entire time for two operatives for each of the old-style machines. By the oxy-acetylene process it is possible to temper sixty-odd feet of saws a minute, which is approximately five times the best speed possible by the old method. The use of oxy-acetylene for tempering has made it possible to maintain constant production, a factor that was not obtainable previously, due to variations in the local gas service. City gas pressures in the winter time were low and production was proportionately cut down, and regardless of the season a fluctuation of the pressure on a single run of saws would develop hard and soft spots which would cause rejection of finished material when subjected to final inspection.

The development of oxy-acetylene tempering, which is now



Saws Tempered by Oxy-Acetylene.

standard in the manufacture of hack-saws and band-saws, is the result of a service rendered to a very well-known manufacturer. The service was not solicited and at first it was not greatly appreciated, because the manufacturer did not believe that the troubles he was experiencing could be avoided by effecting a change in the tempering process. But while the service engineer was given little encouragement at the outset, his ideas eventually prevailed. Today the oxy-acetylene method is standard to this company's production.

In concluding, it is worthy of remark that the mining organization which is probably getting the most out of the oxy-acetylene process today is one that was among the first to recognize the importance of having a central welding shop as a distinct and definite department. When this fundamental truth is realized by the mining industry as a whole, the present demand for apparatus, gas and supplies will undoubtedly be multiplied manyfold. The responsibility for carrying the oxy-acetylene message to the mining world should be shouldered by everyone in our own industry who in any way comes in contact with mining men.

The Chicago office of the Transportation Engineering Corp., manufacturers of the Wanamaker Electrodes, have moved from 608 S. Dearborn St. to 220 S. State St.

It is reported that the Gas Tank Recharging Co. of Milwaukee, Wis., is planning the construction of a new one story manufacturing plant which will include a carbide storage building, boiler house, purifying plant, shipping and storage building, and a recharging plant.

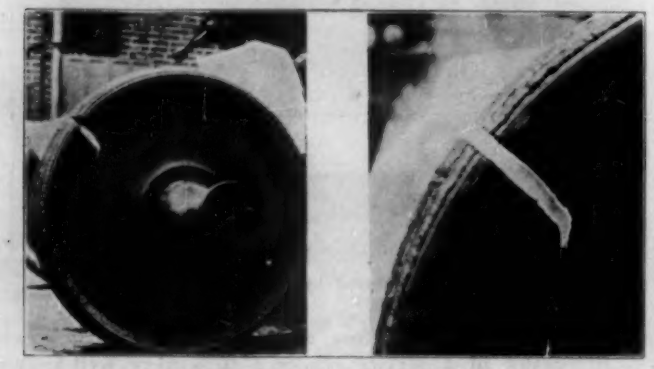
ARC WELDING OF CAR WHEELS

New Method of Preheating Neutralizes Internal Strains and Makes Permanent Repair More Certain

ONE of the most difficult problems confronting the welding department in the car shop is that of building up on the treads and flanges of worn wheels. The work has been done with varying degrees of success by the electric arc process, but it cannot be said to have been absolutely perfected. The railroads have worked long and hard on the problem, and expert welders and employers of different lines have worked out some ingenious methods for getting the best results with the least possible number of failures.

Among the most recent developments is that of using automatic arc welding machines for this work. Results so far obtained in some instances have indicated that the use of automatic machinery helps considerably to meet the need for exactness.

An important point which appears in the consideration of this problem is that it does not seem economical to remove wheels from axles for the purpose of building up the worn areas. This means that annealing or preheating to a high temperature is not practicable; but continuous welding on the



Car Wheels Cracked After Welding.

cold metal subjects the wheel to a repetition of expansions and contractions, causing cumulative strains which result in cracks. It is also agreed that broken wheels and the breaking of wheels during the welding operation are often caused by stresses which are left in the wheels during the manufacturing process, and which are increased by the effect of the hot arc when they are welded.

An investigation of a failure of this sort which occurred while welding a wheel immersed in cold water, or while putting on the second layer immediately after finishing the first layer showed a great deal of internal straining and enormous addition of external strain due to the shrinking of the first layer of the weld. Therefore, it is highly important to take into account the magnitude and distribution of these stresses and their influence on the successful welding of car wheels.

It has always been recognized that internal stresses are present in car wheels as a result in the manufacturing process, but their location has never been carefully checked. A more careful study is evidently necessary. When it is planned to subject the wheel to stresses other than those caused by the ordinary loading and service, for it is certain that any stress producing operation performed on the wheel adds to the stresses which are already present and produces a dangerous condition, some means must be provided to neutralize them in some degree to get rid of all of the stresses which are apt to give trouble.

Welding by the electric arc or by the oxy-acetylene flame will in itself tend to produce additional stress. The local heating to fusion of only a small portion of metal produces a tremendous straining in adjacent portions or parts which in turn influences the freezing of the deposited metal, causing heavy straining in its by rapidly carrying away the heat by rapid cooling from the molten condition. This effect is still more pronounced because the operation is conduction while the wheels are on the axle, the weight of the axle pressing on the wheel and setting up stresses in the hub and plate. It should be noted that these stresses are added to the ones already present in the wheel and those set up by the welding operation.

Arc welding may safely be said to present more of a problem in this operation than oxy-acetylene welding, because in the former the heat is more highly localized, while in the latter the heat is spread out to some extent during the interval of bringing the metal to the point of fusion. For this reason it is of greater importance to guard against cumulative stresses when welding on the arc than when doing the work with the torch.

It is also worth noting that when working on car wheels we must consider stresses and strains due to mounting and due to uneven cooling from high heat after rolling. The process of mounting the wheel on its axle produces a radial compression in the wheel. This compression is, of course, greatest in the hub and decreases in the plate toward the rim becoming very small at the tread. There are also tensional stresses produced by mounting which may be assumed to increase near the rim. Still they must be assumed to amount to something, and when added to the stress caused by the uneven cooling of the different parts of the wheel from the rolling heat, it would only require a comparatively small additional straining to cause a rupture. One of the photographs accompanying this article shows a 38 inch rolled steel car wheel which broke while it was being welded. It is quite possible that the poor grain structure may have been a large contributing cause to these failures, but is also safe to assume that internal stress had a share in causing it. In fact, microphotographs were made of the grain structure of this wheel and did not show any abnormal conditions.

When steel wheels are cooled from the rolling, pressing or forging heat, changes of volume are brought about at different times, resulting in elastic strains set up to disturb the equilibrium. A certain amount of inelastic straining takes place at the junction of the rim, and at the junction of the hub and plate. The cause of this can be found very easily in the fact that the cross sections of the different portions are unequal, consequently the cooling is bound to be uneven. It is generally agreed that manufacturing processes cannot fail to leave the wheels with a certain amount of these strains present, and it is reasonable to assume that the strains caused by the local heating of the electric arc furnish enough additional pulling power to cause such breaks as shown in the illustration.

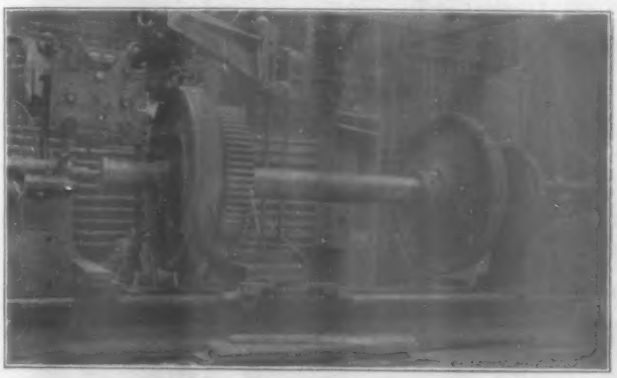
Having investigated the various stresses which lead to failures in welding, it remains to investigate the methods used to reduce the internal stresses to a point which will permit the addition of the stress set up by the electric arc welding process and have the resulting cumulative strain below the elastic limit of the metal.

A favorite method of building up worn wheels is to interrupt the continuity of the metal and let a small section of the deposited metal cool while more metal is being added on a

portion of the wheel at a considerable distance from the first deposit. This is common practice and results indicate that when it is followed the liability of failures is considerably reduced. The biggest drawback with this practice is that the results are fairly uncertain, and there is the danger that the wheel welded in this manner may stand up all right during the welding operation but break down when additional strains are set up due to loading, moving over uneven tracks, and sudden application of brakes.

A less popular and less desirable practice for reducing the amount of cumulative strains is that of keeping the wheel cool during the welding operation by immersing it in water except for the small porton which is left exposed to the action of the electrode. Regarding this process it is sufficient to say that it was used in the welding of the broken wheels shown in the illustration already referred to.

The latest development toward the solution of this problem is found in a method for which the Westinghouse Electric & Mfg. Co. has a patent pending. The principal feature of the process is the selective heating of parts of the wheel before, during, and after the deposition of metal by automatic continuous arc welding machinery so as to change the magnitude of physical dimensions of the wheel a desired amount, thereby producing a strand or series of bands of arc deposited metal of linear dimensions or links to fit snugly around the circumference of the tread and flange without increasing unduly the stresses in the wheel caused by contraction when cooling. The operation of the process is as follows:



General View of Device for Preheating Wheels to be Welded.

The wheels are mounted on the axle and the axle is suspended on the centers of lathe. A pair of semi-circular burners are attached to the wheel and set at approximately one-fourth the radial distance of the plate or between the hub and rim and close to the concaved side of the plate. If the heating is done by gas as shown in the photographs, a ½ in. pipe is used, drilled with three 1/16 in. holes at a 45-degree angle around the inner quadrant of the circumference, directing flames against the hub plate and rim of the wheel.

The wheel is heated to approximately 250° C. before the welding is started. The first layer of strands is deposited on the tread and the temperature of the wheel is gradually increased to between 350° C. and 450° C., care being taken not to exceed the latter temperatures. The second and third layers are deposited while the wheel is kept at this heat and the flange is built up, the temperature gradually being reduced to approximately 200° C. When the welding is finished the heat is turned down so that the temperature of the plate falls to about 150° C. The heat in the rim and the hub is dissipated to a point where the temperature is about 60° C., or where the hand can touch the wheel without danger of being burned. Then the heat is turned off entirely and the whole wheel is allowed to cool to room temperature. The heat application described above is fairly uniform, and is of sufficient intensity and is applied for a long enough period of time to reduce the interral straining to values which will allow the external strains produced by the shrinkage of the arc deposited metal to be added without danger of exceeding the ultimate strength of the metal in the wheel.

By way of explanation it may be said that the low starting temperature (250°C) is employed to bring about a gradual release in the internal straining and disturbances which may happen in the throat of the wheel and fillets of the plate and rim, and those in the hub due to the mounting of the wheel on the axle. The higher heat, which is not quite sufficient to turn the metal red, is sufficiently high to completely remove internal straining, and to remove all or any accidental chilling effect to which the wheel may have been subjected after rolling while its cools from the high rolling heat. The maximum temperature noted (450°C) is not high enough to cause any refinement of the grain structure, nor to cause any coarsening of the structure. The increased physical strength of steel at these high temperatures may also be assumed to constitute a contributing factor to the success when this procedure is followed.

Preheating Flame. **Full Flame.**

Note that the second and third layers of deposited metal are approximately ½ in. longer on this hot 37 in. diameter wheel than when put on a cold metal, and on cooling they contract to the natural dimensions of the wheel with the rest of the metal, without subjecting the wheel to abnormal and compound stresses.

The lower heat in the wheel during the welding of the first layer and the subsequent raising of the temperature for the welding on of succeeding layers puts the first layer under tensional stresses. The effect of these stresses is similar to the hot working of this layer. When on depositing the succeeding layer it is deposited at almost a fusion temperature so that by judicious selection of conditions a noticeable increase in the physical strength will result.

Problems of a similar nature are encountered in the car shop when arc welding is applied to the building up of car axle journals. A careful microscopic examination of the grain structure reflects the presence of three zones of entirely different steels within the cross section of the axle. This condition is very objectionable, and is unfavorable to the exacting requirements of the axle. A process to diffuse or broaden the band of this fusion zone in arc welded axles, to neutralize its weakening effect and to improve the arc deposited metal has recently been developed by the Westinghouse Co. It consists of heating the welded shaft portion to an annealing heat and quenching it from this temperature. The heat is applied by an electrically heated muffled furnace and is concentrated upon the welded portion. Water cooling keeps the rest of the shaft from materially changing its structure.

How Pipe Line Welding Crews Are Organized

Welding Crews on the Job. Portable Generator is Shown at Right.

WELDED pipe lines were introduced into the Mid-Continent oil fields two years ago and have since gained rapid favor. This type of installation has reduced the initial cost of pipe line construction by 30 per cent, when compared with screwed coupling lines.

The first welded line for transporting oil was laid by the Prairie Pipe Line Company in December, 1920, between Bartlesville and Ramona, Okla. It was an 8-in. line, 15 miles long. Despite inexperience, short lengths of pipe and extreme cold weather, the cost of this line was but 5 per cent in excess of coupled construction. Since then this company has adopted the welded line exclusively. Many other concerns have used welded construction to some extent, the chief drawback being lack of long-joint pipe, with plain beveled ends.

Welding the Short Lengths. Making the Bell Hole Weld. Getting Ready to Put a Welded Line Across. A Mile or So of Welded Pipe.

For an extensive pipe line project, welding is accomplished in three stages. First there is the welding crew, having four welders, who weld five lengths of 40-ft. pipe. These are followed by the tie-up welders, who join two of these 200-ft. lengths of pipe. Then the 400-ft. lengths are welded to the line by the "bellhole" welders.

For this work open-hearth pipe, 40 ft. long, having plain ends, beveled toward the inside, is desirable. This pipe is first strung along the route of the line. Ahead of the welding crews, is a force of men, who place this pipe on blocks, five joints in each section, with the ends butted firmly and held securely with clamps. No other preparation is necessary for new pipe, unless it is rusty or dirty, when it is cleaned with a wire brush.

Each welding crew, two of which usually work under the direction of one foreman, is provided with a generator. This is mounted on a farm wagon. A hoop around the generator is bolted to the wagon bed. Pipes are extended from the generator to the end of the wagon bed, where regulators are installed and hose attached. Each wagon is equipped with an oxygen bottle rack. A generator man is part of each crew.

For each pair of generators, another wagon is equipped with a water tank of 250 gallons capacity. It has a pump, assuring ample water not only for flushing the generator tanks, but also for filling them before a new charge of carbide is put in.

A generator is halted near the middle of the five lengths of pipe to be welded. Two pieces of hose 75 ft. long are provided for the welders working at each end of the section. Inside welders have 50-ft. pieces of hose. Each welder finds his joint held by a clamp. He then takes two or three "tacks" in the joint, after which the clamp is removed and sent ahead for the next weld. Half the joint is welded. Then with the aid of helpers, the whole length of pipe is rolled on its blocks and the weld completed. The whole joint is "built up" with welding rod.

After the welding crew moves on, the tie-up men weld each pair of 200-ft. lengths of pipe by similar methods. A portable acetylene tank is provided for each tie-up crew. Two abutting lengths of pipe, each 200 ft. long, are held in line by a clamp until sufficient welding has been done for the clamp to be removed. The pipe is rolled on the blocks and the unwelded portion of the joint kept convenient for the welders.

The most difficult part of the process is left to the "bellhole" crew, sometimes one welder but more often two. This name comes from the fact that a hole must be dug beneath the joint for the weld to be made. Behind this crew is frequently several miles of welded line. Consequently it cannot be rolled for the convenience of the welder.

Sometimes the pipe has been dragged into the ditch before this weld is made. Again it may be left lying on the ground. In either case a hole must be dug beneath the joint, of sufficient size to allow the welder to work from below. A 400-ft. length of pipe is brought to the several miles of welded line and a "jack" attached to hold it uniform during the weld. This jack consists of two chains and a lever, by which one man can hold the pipe securely. While the pipe is held firmly with this device, two men usually complete the "bellhole" well, one working at the bottom side of his half of the joint, while the other works at the top, reversing positions as they progress. Because of cramped positions when working beneath the pipe, this weld is extremely difficult. Acetylene and oxygen for this welding is supplied from portable tanks.

Some idea of the progress made in following this program of welding can be told from the fact that one such complete crew working in Kansas, November 4, welded 8,000 ft. of 8-in. line within 8 hours. Conditions were only fair for the work.

With the welding complete, the line is ready for a test, then for painting and then for covering. The test is usually made with water, often under pressure as high as 800 lbs. When leaks result, the pipe is cut with a cutting torch and the joint re-welded.

Because of short lengths of pipe, the first 15 miles of line laid by the Prairie company required 4,200 welds. Still only two leaks were found when the line was tested. In the line completed by this company between Jacksboro and Mexia, Texas, 140 miles, 18,500 joints were welded and the test developed but four leaks. This company last August welded an Oklahoma line of 14 miles without a defective weld.

There is a "knack" to pipe line welding, to be learned from experience only, according to men who should know. A fear held by many, who contemplated welded lines was that of dripping, or "icicles," of metal getting inside the line at the joints. These would hamper the use of the "go-devil," a device with which oil pipe lines are cleaned. This fear proved groundless, as the first line welded by the Prairie company permitted this device to pass through in a hour shorter time than is required for screwed coupling lines.

Concerning the prevention of this, or the "knack" of welding pipe lines, N. E. Wagner, superintendent of welding for the Prairie Pipe Line Company, has this to say:

"It is much easier to show on actual work how a weld is made without dropping metal through, but for explanation we only say it is the angle at which the welder holds the torch and his handling of the rod properly, which makes it almost impossible to drop metal through. It is the fault of the welder, who may be incompetent, if he burns through."

Welded joints have been found an improvement over couplings for river crossings. For these, extra heavy pipe is required. This is welded and dragged to the bank of the stream and placed in the ditch. On the other side, a joint of pipe is rigged up across the stream as a windlass. A wire line is run across and tied to the welded line, which is plugged. It is pulled across the stream by the windlass. Then fire bands are built on either side, heating the pipe and allowing it to bend to the bottom of the stream.

Crossings thus welded have withstood floods, which have broken coupled lines that had the protection of heavy river clamps. The action of water seems to weaken coupled joints.

One concern has reclaimed 70 miles of pitted pipe through welding. These lines had been eaten by alkali in the soil. They were cleaned inside with a "go-devil." Then the pipe was uncovered and scraped to determine the depth of pitted places. These were then filled with welded metal, painted and relaid.

INSTRUCTIONS FOR MAKING THERMIT COMPROMISE WELDS

Thermit compromise rail welds can be made just as easily and quickly as any other weld. They can be made in the track or in the shop. Where large quantities are desired of the same style, it pays to obtain special patterns and mold boxes in order to facilitate the making of the weld. Where, however, only a few are required or where various combinations are required, a wax pattern can be applied directly to the rail and mold rammed against it. The wax pattern should conform as closely as possible in shape to the aluminum pattern ordinarily supplied for rail welding and is easily shaped by hand.

A very simple and efficient way of making a wax pattern is to melt the wax in a suitable pan to a liquid stage, 1 in. thick. This is allowed to cool until the top surface has become solid. The lower part will still be plastic. Cut into strips 2 in. wide and apply around the rail ends. The wax will be sufficiently soft to be easily manipulated by hand to the desired shape and thickness for the weld. It is advisable to imbed a cord about ¼ in. thick in the wax, leading from the riser to the heating gate. This cord can be pulled out leaving a vent hole which greatly facilitates the melting of the wax during the preheating. A regular sand mold can then be rammed around the wax pattern using wooden patterns for pouring gate, riser, heating gate. The preheating melts out the wax and leaves the mold ready to receive the Thermit steel as soon as the rails are red hot. The rest of the operation is the same as in the case of the regular rail weld.

It is a simple matter to calculate the quantity of Thermit required from the weight of the wax used in the pattern. It is best to weigh the wax before starting and weigh what is left over—the difference being the amount in the pattern itself. Allow 20 pounds of Thermit rail welding mixture to each pound of wax. This will be sufficient for the weld.

HUNDRED FOOT WELDED TOWER

By Howard L. McLean

An unusual job of electric arc welding has been recently completed in a cave near Vallecita, California. This is a hundred foot tower built up of spiral strips of steel enclosing a spiral stairway. Every joint of the 7200 in the structure, was welded by the electric arc.

Compared with the other projected method of construction using structural steel, the welded job showed to very great advantage. The engineer responsible for the design and construction, A. H. Tangemann of Stockton, estimates the weight of a bolted and riveted structural steel tower at about 13 tons. The steel used in this lattice tower ran a trifle over 3 tons. The cost of the completed tower was $3,000. The lowest estimate on a riveted structural steel tower for the same purpose was $12,000.

Welding Saved a Small Fortune Here.

WILLIAM B. DEAN

With profound sorrow we announce the death of Mr. William B. Dean of the firm of Nichols, Dean & Gregg, St. Paul, Minn., on Tuesday, December 5, 1922. Mr. Dean has been associated with the above company since 1857.

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PRIZE WELDING STORIES

Welders Describe Methods of Getting Good Results on Jobs That Appeared to Be Unusually Difficult

NOVEMBER PRIZE STORIES

The following three stories have been selected from the stories submitted in response to our advertisement published in the November issue of THE WELDING ENGINEER. Announcement of the prizes awarded for the stories in the December issue will be made in the February issue of THE WELDING ENGINEER. In all cases the awards have been made on the basis of the practical value of the instruction contained in the story, from the point of view of the man who desires to accomplish a similar job. The three stories printed below will give the welder a variety of useful information, the first one dealing with the subject of giving a finished appearance to a cast iron weld,, the second telling how failures were overcome in a patching job, and the third furnishing the details of procedure in making large manifolds.

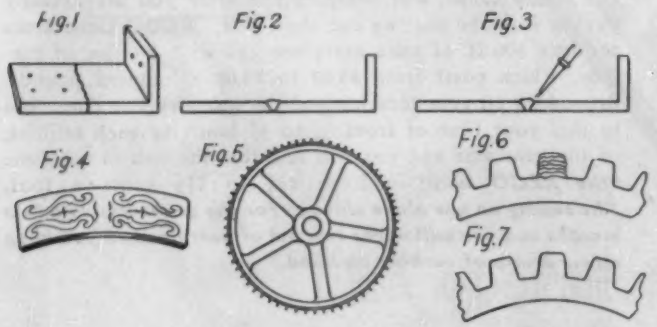
FIRST PRIZE

L. S. Huling, Kansas.

CAST IRON WELD

It is often desirable to make a cast iron weld present a good finish without having to resort too much to machining and grinding. If proper care is exercised in the welding, it is possible to make a weld in cast iron which will really be hard to find. Of course, the most important part is in the beginning. It is necessary to get all foreign matter out of the weld and keep it out.

The standard method of procedure is to first grind the bevel to 45 degrees, then grind back on the surface along the line of the weld about ⅛ to ¼ of an inch, just taking off the surface



Cast Iron Welds.

so that not only the line of the weld but also the adjoining surface will be free from all impurities. Of course, there are some castings which contain large holes due to impurities which are in the metal when it is cast, and very often these holes are in the line of the break. They should be ground out entirely, if possible. When all the cleaning has been finished, I bring the parts to be welded to a melting point, heat the filler rod to a bright red, dip it into the flux and stick the end of the filler rod directly into the line of the weld, allowing it to make contact with the molten metal for an instant. The flux immediately acts on the molten metal and the puddle is formed. The heat is concentrated on the filler rod so as to bring it to the welding point as soon as possible, at the same time keeping the puddle in a molten condition. The end of the melting filler rod is worked into the puddle, and the contact between the two is kept until the desired amount of metal has been deposited. If this work is done steadily, the entire V may be filled without using any more flux, because the rod will fuse with the mass already welded under the protection of the oxide film already formed. Of course, in the case of a large weld it is necessary to repeat this operation several times. It is best to keep the rod moving as in puddle welding, as this helps to keep the oxide floating. I found that this procedure followed on small cast iron welds produces a weld which can easily be machined without any further attention except allowing it to cool in a dying bed of coals or buried in lime.

The reason for going into such detail regarding the welding operation is that if we wish to give the weld a finished appearance without machining, it is necessary to keep it free from all impurities. Take, for example, a magneto bracket as illustrated in Fig. 1. The weld should be made as described above until the V is a little more than filled, as shown in Fig. 2. Then, while it is still at a very high heat the flame should be directed at the edge of the added metal as in Fig. 3, and run along this line working the ridge out over the body of the casting until the line of weld disappears under the film of oxide. It is not necessary to disturb this film; simply proceed as mentioned above on both sides of the line of weld and around the casting until the job is finished.

Fig. 4 is a rough sketch of a stove plate casting, which is a more difficult piece to handle. This will not be considered worth while in a job shop in a large city, but in the smaller localities we have to remember that the lady of the house likes to have her stove look nice, and it is often very difficult to have broken stove parts replaced, and that if the welder proves his ability by doing a good job for her she will say just as many nice things about him as the owner of a broken punch press would. In this case the procedure would be the same as before, only I would use more metal where the figures are, not trying to finish while at a high heat but letting it cool down to about 1,200 degrees, and start to build up from the bottom of the raise. A very satisfactory job can be made after some time is spent practicing.

Fig. 5 represents a very common job of welding a broken gear tooth. It is not unusual to be called out with a welding outfit to do this job on the spot. When the wheel is a large one I go ahead and build up the tooth about as shown in Fig. 6, then as soon as the building up process is finished, turn up a little more oxygen than is needed for a neutral flame and begin cutting off at the cool end of the tooth. This will take off the surplus metal before the body of the tooth can be affected, and with a little practice can be done very smoothly so that it is only necessary to scrape off the surface ,put plenty of grease on the tooth, and put the wheel into service.

SECOND PRIZE

F. E. Totten, West Virginia

PATCHING A BOILER

One of the most interesting jobs of my experience was a boiler welding job, the details of which may serve as both a warning and a help to other welders.

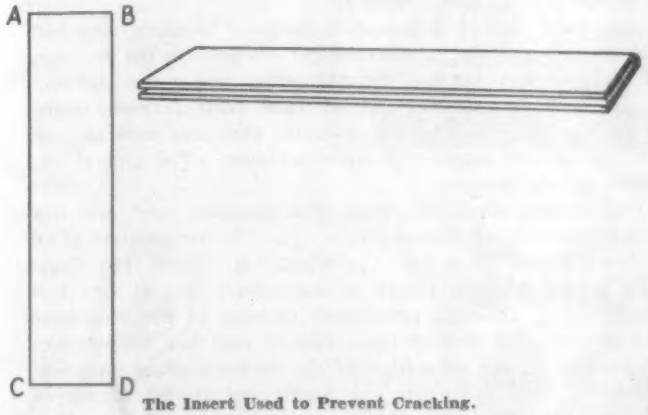
One day a mine about twenty miles up country, in reality up in the mountains, sent us word to put in a new door ring and weld in a patch around the door on the firebox side of a boiler. We made them a cast iron ring and then the boilermaker went up there to the mine, cut out the defective sheet, and came back late in the evening and cut a new patch out of boiler steel and drilled all the holes, etc.

I came into the shop late in the evening and saw him at work on the new patch. "Are you going to corrugate the patch, or put a roll in it?" I asked him. "No," he said, "the patch is so shaped that the expansion will run out, and any way we are going to set the patch behind the firebox sheet so expansion will

not hurt." I knew full well that the expansion would not hurt it; it was the contraction I feared. I didn't argue with him, as I wanted to hurry home.

Well, the next day was Sunday and I might add that I had to be bribed royally by the boss before I would work that day, as I had planned to take friend wife and the kids up country in the car for a visit to a cousin, but the boilermaker and "Army," the helper boy and myself, loaded up the machine and drove to the mine. We cut the patch and fitted it nicely in the hole and after bolting it so it would stay in place I started to weld. I welded up one side and started to weld the other side and "bing!" it went. Well it was a continuous fight until I got it to look as though it might hold shelled corn. We drove the rivets and stay-bolts, and then I crawled into the firebox to watch for leaks. As soon as the water got up to the patch it nearly drowned me before I could get out.

We, or rather I, welded and the boilermaker caulked until 6 a. m. Monday morning, and got it to hold fairly well. I might



The Insert Used to Prevent Cracking.

add that the patch was as taut as a drum head, it was drawn so tight. We came home and slept and loafed the rest of the day. Tuesday the mine superintendent called again and said the patch leaked so badly it put the fire out and asked us to come back and fix it over.

On Friday I went back and found that they had a fire in it. We pulled the fire and let the water out and I went in to the hot firebox and welded up the cracks again. The boss was along this time and he said "It ought to hold now that it is welded hot" (old stuff). Saturday morning the mine superintendent called again and said it leaked so badly the fireman was afraid of it.

The next day the boilermaker and I went back to do or die, under strict orders to either fix it or not come home again. We fixed it. I made a wide cut in the line of the weld, cutting out the old filling metal. Then we took strips of ¼ in. boiler steel as A, B, C, D and folded them much as you would fold a strip of paper lengthwise, that is superimpose B on A and D on C. These we stuck in the opening with the open end of the strip next to the waterspace. Then the patch was welded to one side of the strip and the old sheet to the other side. When the weld cooled down the construction simply opened up the folded strip and there was no contraction strain whatever. We did this all around the patch and it was a perfect success. The boiler has been in use every day since, and is perfectly dry. The boiler inspector inspected it and passed it O. K.

I have since used this device to weld vertical cracks between stay-bolt holes in locomotive fireboxes, and it works fine. There isn't the least danger of a weld cracking when the folded insert is used, as all the contraction takes place in the insert, and it simply opens on the open end until all the drawing strain is neutralized. *However, it is better to dish or corrugate your patches in the first place.* It is a wonderful help, though, when welding cracks in a straight sheet like a locomotive firebox.

THIRD PRIZE

Edgar H. Trick, Texas

MAKING A 16-IN. GAS MANIFOLD

The manifold shown in the accompanying illustration was made by the Alamo Iron Works of San Antonio, Texas, for the Public Service Company, of that city, to carry artificial gas.

The manifold was made of standard weight 16-in. steel pipe and fitted with standard low pressure cast iron flanges. The length of the main portion was 8 ft. 3 in., and the two horizontal leads were 5 ft. long. The vertical outlets were 2 ft. 2 in. long. The outer ends of the two horizontal leads were cut to the correct shape and closed by welding on the pieces, which were formed by cutting the holes to attach the vertical outlets.

One end of the main length was fitted with a standard cast iron flange and the opposite end was closed in a manner similar to the ends of the two horizontal leads by using one of the pieces cut out where the horizontal leads were welded on. Correct shapes for the holes and ends were secured by carefully made sheet iron templates laid on the pipe. Alignment for tacking was secured by laying the pipe in short heavy section I-beams laid flat. Alignment of the vertical leads was secured by bolting a straight piece of 1x8-in steel bar across the faces of the flanges.

A Welded Manifold.

Only one annoyance was experienced throughout the job, and that was due to the machine shop having but two of the standard cast iron flanges available when the job was well under way. That necessitated the removal of the flange at the end of the main section of pipe so that it could be used on the end of one of the vertical leads to secure proper alignment—the horizontal leads being the first ones to be welded. Since the weld was but a few inches removed from the threaded end of the main pipe the strains set up by the heat asserted themselves immediately upon the removal of the cast iron flange, allowing the end of the pipe to assume an oblong shape. Considerable difficulty was experienced in getting a flange back on this end, although a screw jack and hard wood blocks, sawed to fit the curve of the inside of the pipe were used in an effort to push it to approximate roundness; the cast iron flange had to be returned to the machine shop and a starting fillet bored out of it to facilitate the entry of the thread end. The completed manifold was tested to 60 lbs. cold water pressure and painted with rust proof paint.

A new plant of the Prest-O-Lite Co., Indianapolis, Ind., is contemplated for New Orleans, La. Location will be at Upperline St. and the 17th St. Canal.

The Welding Engineer

Reg. U. S. Pat. Office.

Published on the 17th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,

608 S. Dearborn St., Chicago, Ill.

Telephone Wabash 7134.

L. B. Mackenzie.....President and Editor
H. S. Card.....Associate Editor
R. L. Miles.....Associate Editor

Subscription payable in advance and postage free.
United States and possessions and Canada.....$3 a year
Foreign Countries.....4.00 a year
Single copy, domestic.....25 cents
Single copy, foreign.....30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 15th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails.

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VOLUME 8 JANUARY, 1923 NUMBER 1

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Problems Related to the Hardening of Steel

ONE of the most fascinating and yet obscure subjects in ferrous metallurgy concerns the problem of the hardenning of steel by a suitable puenching treatment and a subsequent tempering of it by slight heating. The interest is centered around the hard constituent or structural condition. known as martensite, the name being derived from the noted German metallurgist, Martens. An investigation has recently been completed by the Bureau of Standards which has a bearing on this general subject, and Scientific Paper No. 452, entitled "Structure of Martensite Carbon Steel and Changes in Microstructive Which Occur Upon Tempering." This paper may be secured at 15 cents per copy from the Superintendent of Documents, Government Printing O¼ce, Washington, D. C.

The study with which this paper deals was based upon the microstructure of a series of steels of progressively increasing carbon content when hardened under different conditions of temperature and heating periods, and the changes in structure which ensue in the same upon tempering.

Practically nothing is gained in hardness by using very high temperatures or very long heating periods prior to the quenching of steel, provided that the "critical" temperature is exceeded upon heating. This conclusion was based upon small specimens treated in the laboratory, in practice, of course allowance must be made for the size and shape of the pieces treated. The general conclusion is valid however.

The changes which take place in a hardened steel upon tempering occur in well defined stages. Until the temperature of reheating exceeds 250 or 300° C. (480-570° F.) no marked change is to be noted in the visible microstructure, even at very high magnification, although pronounced changes in the dimensions and density often do take place even at such low temperatures. Above 250° C, the separation of the carbon-bearing compound, cementite, from the martensite begins and at 400 to 500° C (750-930° F.) the steel shows a very fine granular structure under the microscope. As the temperature of reheating is increased, the granules increase in size, although a high magnification is still required for seeing them, and the steel becomes softer and finally loses all of the high tensile properties it gained by the hardening treatment.

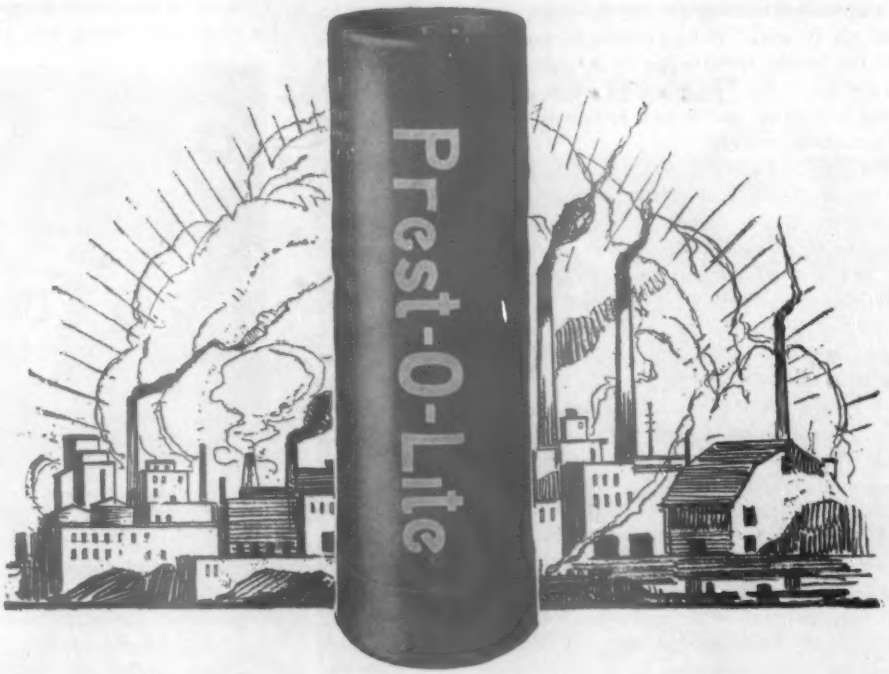
Another Possibility for the Job Welder.

IN this issue will be found a complete description of the welding of a steel floor for the milk receiving room of a large chocolate factory. In the course of the discussion of this job the author calls the attention to two important requirements of the floor. One was absolutely perfect sanitation, and the other was ease of making repairs. This opens up a new and interesting field of action for the job welding shop.

Nearly every community which can support a job welding shop also supports a dairy, or other food-products industry. It is quite possible that the owners of such establishments are not thoroughly satisfied with the present conditions of their floors, and if the advantages of a welded steel floor were pointed out to them, it might possibly result in a very attractive contract. At any rate it is worth trying. The welder can at least approach the proposition with the assurance that it is possible to produce a floor which will be perfectly satisfactory as far as sanitation and maintenance are concerned.

Building the Welding Department

THE foreman of the welding department usually has to build his own job, because his superiors are not familiar enough with welding possibilities to realize what a bigger department could accomplish. Let him use his power of observation in turning up new jobs for his men, and he'll find his own job growing in importance. If he is a real live one, he will find work for more welders by finding out how many different jobs are being handled by other welding departments.



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WELDING A PLANER BED CASTING

By C. M. Belcher.

The planer bed casting is 1¼ in. thick, 25 ft. long, 2½ ft. high and 2¾ ft. wide. It was broken in fourteen different places. Most of the breaks were in the cross pieces or bridges of which there were six, every bridge having from two to three cracks in it, one leg broken off and broken in two with a large piece broken from the casting entirely.

I started by building a brick furnace, taking up the casting as far as lines are shown, being very careful not to heat any more of the casting than I could help, but what I did heat was brought to a dark cherry red and kept at that heat until the weld was finished. Then I closed the furnace as tight as possible, using sheets of asbestos for the top, and stopping all the cracks between the fire brick until fire clay, which made it almost air tight. It should take at least eighteen to twenty-four hours to cool the casting after closing the furnace. This I kept up until I had all the cracks welded in the cross pieces or bridges. Then starting to weld the casting together, I blocked both ends of the casting very carefully to keep it in place during the expansion and contraction period. This you can do very easily by laying a perfectly straight shaft in the groove, which is indicated by number eleven. Do this to line the casting as it is the easiest and most convenient way; then block the casting on both sides. This must be done securely if it is expected to stay. Build a neat furnace large enough to bring the casting to a dark cherry red. Heating this does not mean to heat the whole casting. Just heat enough to take in the break, which on this casting was about 1¼ ft.

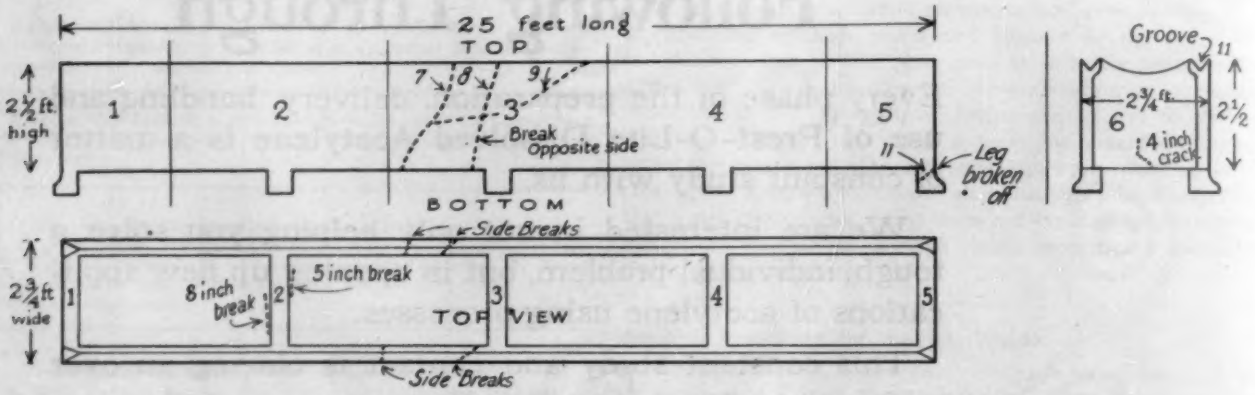
Three Pieces of Direct Advertising used by a Welding Plant in Kingston, N. Y.

CALENDARS ARE THE FAVORITE AD OF THE WELDING SHOP

The distribution of calendars at the beginning of the year seems to be one of the favorite ways of advertising in the job welding shop. Other forms of direct advertising are used at frequent intervals, but an attractive calendar seems to lead them all in popularity.

In the accompanying illustration are shown three pieces of direct advertising used by the C. P. Ashley Welding Works of Kingston, N. Y. The calendar he supplies is a weekly calendar instead of monthly. It is put up on good rugged stock, and is just the thing for the garage or machine shop. Two of Mr. Ashley's mailing cards are also shown in the illustration. One of these is a reproduction of a display ad, and the other is a reprint from a local newspaper telling how useful the portable welding outfit is to the community.

Some of the other firms who are using attractive calendars for their advertising this year are the Maryland Welding Co., Baltimore, and the Kansas City Oxygen Gas Co., Kansas City, Mo. Both of these firms are issuing very artistic wall pieces. An unusually interesting one has been received from the China Oxy-Acetylene Welding Works, Shanghai, China. This one carries the welding message in both English and Chinese.



Welded Planer Bed Casting.

I also used carbon blocks so as to reinforce the weld about ½ in. after welding breaks seven and eight. I allowed the furnace to cool off gradually by stopping all the holes again with fire clay, then rebuilding another furnace in the same place I put the piece indicated by number nine in place, started a very slow heat, taking six hours to get it hot enough to weld. After welding I stopped the furnace as usual, covering the top with asbestos or sheets of iron. After making all the welds and taking my furnace down, the casting was as straight as before breaking.

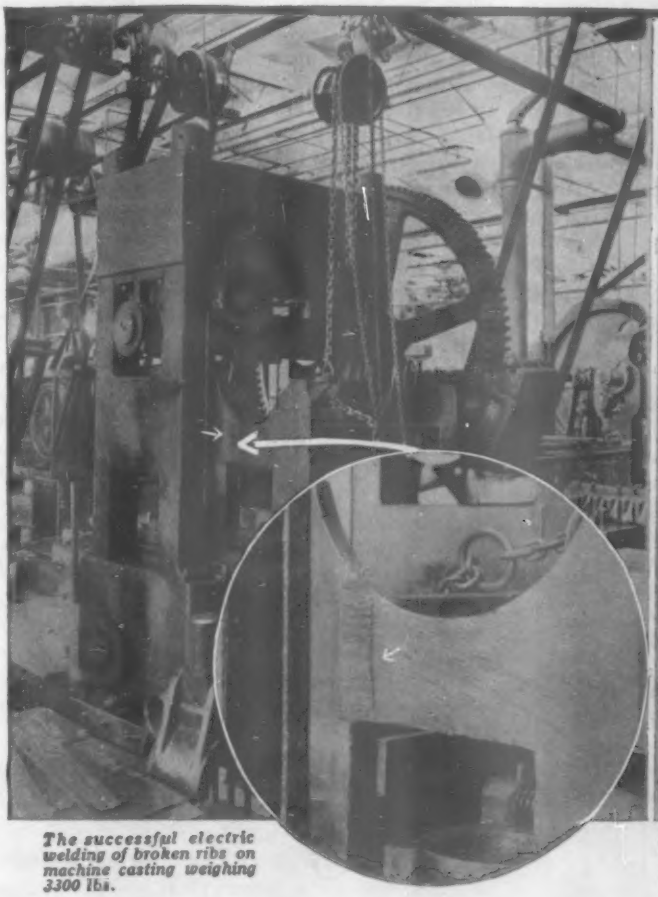
THERMIT WELDING OLD RAIL

Welding old rail by means of the Thermit insert process is entirely feasible and very simple, providing the rail is not too badly corroded and pounded at the joints.

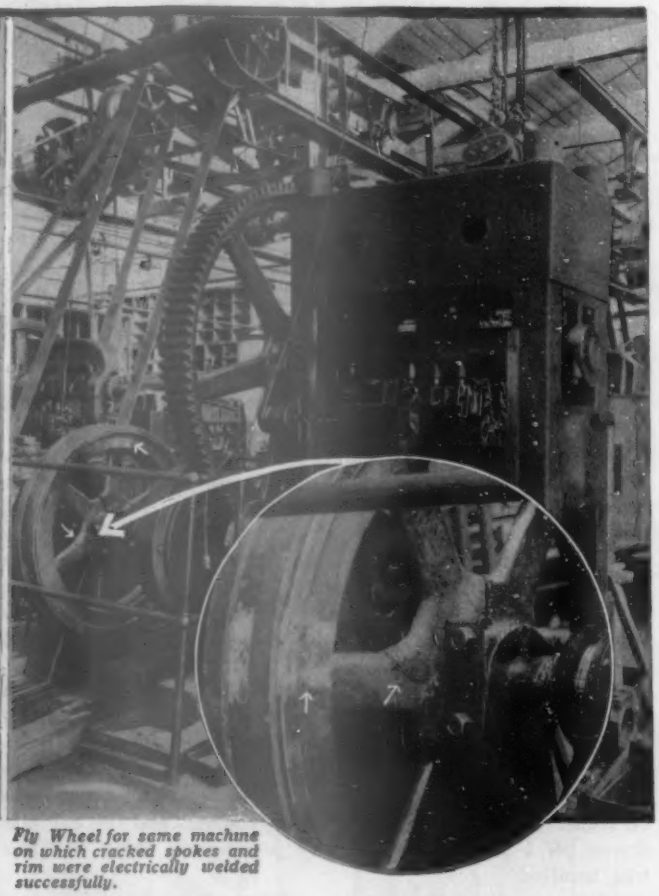
Where the rail is in good condition and only slightly pounded, the weld can be made without cutting in a new piece of rail. In such cases, the receiving rail can be raised until the lower part of the cup is on a level with the running surface. The end of the discharging rail can then be cut off about ½ in. to ¾ in., thereby eliminating the battered end and at the same time providing a gap for the thermit insert. This procedure after grinding entirely eliminates the battered joint and restores a running surface equal to that of a new rail. The usual method of making the weld is then followed, except that in some cases it is necessary to do a little hand-luting with fire clay around the edges of the mold boxes, in view of the fact that it is quite impossible to design patterns which will conform exactly to the contour of rail which is partially worn.

Where the joint is very badly pounded, cut in a short piece of new rail (not less than 8 ft.) and make two welds. The second weld should not be made until the first weld has cooled.

Electric welding saved this machine



The successful electric welding of broken ribs on machine casting weighing 3300 lbs.



Fly Wheel for same machine on which cracked spokes and rim were electrically welded successfully.

The following extract is from a letter to us by Enoch Ohnstrand, Chief Engineer, LIBRARY BUREAU, Ilion, N. Y.

"We figure that this repair on this machine showed a sufficient saving to pay for the installation of our electric equipment, as the machine which was broken down was a special machine made years ago for this Company, and even if it had been an up-to-date machine, we could not have purchased this part for anywhere near the price of the electric welder which we purchased from you and which we used for doing this work. I am pleased to advise you that we got splendid results from the job and in a very short time. The repairs, so far as welding was concerned, were made in about three hours actual time."

The line of G-E Electric Arc Welders includes types of stationary and portable sets for hand welding—and automatic and semi-automatic machines. G-E Specialists are at your service to select the equipment essential in electric welding processes for repairs, production or salvage in your plant.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

43B-711

WELDING KINKS FOR THE GARAGE

A Suggestion for Welding Automobile Bumpers— How Piston Can Be Enlarged Without Adding Metal

St. Louis, Mo.
Wednesday.

Dear Ed:—

I picked up a couple of kinks this day that may or may not be new to you but they struck me as being pretty good ones. The easiest way to describe them is to give them just as I received them so here goes:

I was talking to the proprietor of a small shop this morning when suddenly the front door was thrown open with almost enough violence to break if off its hinges, and in bounced a little dandy of a man. Was he all "het up?" I'll say he was. Boy! the air turned blue and then purple. Honestly Ed, this fellow was really sore. To make a long story short, he finally got through telling the boss what a "blankety blank" welder he was, and demanded that he look at the wonderful job done on his car.

"If it's that bumper I welded for you last night, I don't need to look at it. It's probably broken and my only surprise is, that it lasted as long as it did; however long that may have been," the boss spoke up. "You needn't come around here blowing your head off Mr. Black. It won't do you one ounce of good unless you simply wish to relieve yourself. You know very well that I told you it would not hold when welded that way but you told me to go ahead and you'd be responsible. We have welded too many of those bumpers not to know what's going to happen unless it's done right. Now if you want us to take your bumper off and do a first class job, we'll be glad to do it and we can have it ready for you right after lunch, but remember this is a different job and you'll have to pay for it as such."

What happened? Why Mr. Black cooled off just as nice as you please and told the boss to go ahead and do the job up right. So after the bumper was removed and the car was driven off I stuck around to see just how a thing like this was handled.

"Wasn't that fellow a rare card?" the boss asked me, after he got things in the shop squared around and put one of his men to work on the bumper. "He drops in on us right along; knows all there is to know about everything and as you probably noticed is very excitable."

"He sure had me guessing for a minute there, when he first blew in," I commented. "What's his grievance?"

"Why he drove up here last night and wanted us to weld his bumper right on the car, while he waited. I told him that it wouldn't do any good because it wouldn't hold that way. I explained that in order to make a good job the bumper would have to be removed; the end cut off, and a new piece welded on. It was no use, he knew exactly how it was to be done and wanted it done that way. He claimed that we were simply trying to make a big job out of a little one and he knew enough about the game so we couldn't slip anything over on him. Well, we did it his way and you saw the result. We knew what would happen but you can't argue with fellows like him."

"You have a way of your own then, in fixing bumpers," I suggested.

"I don't know about that but we fix a great many of them very successfully," he answered.

Hoping to draw him out a little I asked, "Don't you make your weld where the piece breaks?"

"Not on your life, "he replied. 'That is, if we have anything to say about it. We did in this case and you see what happened. No, there is only one way to do a job of that kind and if you'll step over here a minute I'll show you how it's done."

That was just what I was after so I was tickled to follow him over to the bench where a workman was cutting off a piece from the bumper.

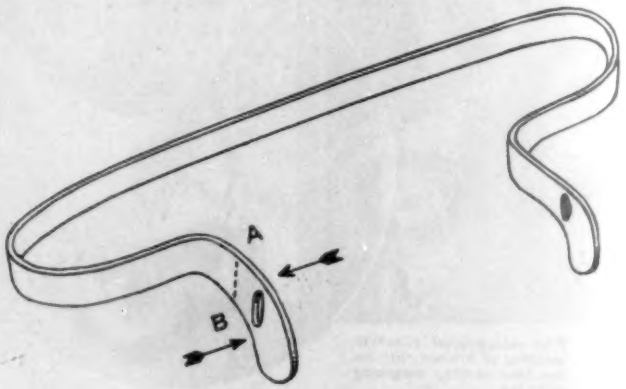
"Bumpers are made of spring steel," he continued, "and are mean things at best to make a weld on. Now I'm going to ask you to point out the weakest part of that bumper for me."

"Why it broke thru the hole;" I answered, "parts usually break at their weakest point so that's my guess."

"Righto! There's no argument there. Now I'm going to have you figure this thing out for yourself before I'm thru. If you were a welder would you like to make a weld at the weakest part or would you prefer to make it at a point where there is less chance of it's breaking?"

"That's easy," I replied, "I'd certainly choose the lesser of two evils."

"That's it exactly." He went on, "if you try to weld the little stock that is left on each side of the hole you haven't a ghost of a show of its holding. That's where all the vibration comes; it's the weakest spot and as I said before,



Automobile Bumper Repair.

spring steel isn't the best metal in the world to make a weld on. Realizing this we simply cut off three or four more inches back from the hole and weld on a new piece of plate steel the same thickness as the bumper stock. Then we use the broken end as a pattern; mark around it and cut out a new end with the cutting torch. Simple, isn't it? By doing it this way you see we have the full width of the bumper to make our weld on and we can reinforce a little on each side."

"But doesn't it make a difference when the piece you weld on, isn't spring steel?" I asked.

"Apparently not," he replied. "We've never had a failure, to our knowledge. Evidently the lack of a spring at this particular joint is advantageous for they never break after being repaired this way. Sometimes they get banged up and bend, but we just bend them back and all's well again."

Now Ed, I don't know how you've been handling jobs like this but perhaps you'll be able to go after the bumper business a little stronger hereafter.

I told you at the start of this letter that I had a couple of good kinks for you and I'm not going to disappoint you. In talking to this same fellow I chanced to mention that I had a friend back in my home town I was picking up new stunts in welding for. He said he never looked upon that bumper repair as being much of a stunt because he had been doing them that way for so long. He seemed a mighty fine type of man and was sorry that he couldn't

think of a rare one to tell me for you. He explained that his shop was operated like every other shop and bemoaned the fact that they were all seemingly in a rut. After we had talked on a little while his face suddenly lit up. "I have it!" he cried, "here's a cracker jack for you. Did you ever hear of anyone making cast iron grow?"

"I most certainly have not" I answered very positively, for something seemed to tell that he was trying to be funny.

"Well, strange as it may sound, it most assuredly can be done and I'll tell you how."

"Before I moved to St. Louis," he continued, "I had a shop in a small town up state where transportation was very poor. It was quite a trick to get replacement parts because they took so long in transit. One day the garage man came to me and asked if I'd do him a little favor. I saw that he had a set of cast iron pistons in his arms, but when he told me that he wanted to see if I couldn't make them grow in size for him, I guess I must have looked at him just about the way you did me just now. But he was perfectly sincere. It appeared that he had read about it some place and wanted to try it out. These pistons he had were worn off on one side.

"He wanted to increase their size sufficiently so that a slight cut could be taken off and make them round. New pistons would take too long to get, so being interested in seeing how they would turn out, I set them up on the welding table. After building up a few bricks around them we packed charcoal all around; put a piece of tin over the top and lit the charcoal. We got them red hot and then let them cool. Well, sir! believe me or not, those pistons turned out to be larger than when we put them in according to his "mics" but he was a little disappointed that they weren't larger. I suggested that if one dose wasn't enough we might try some more of the same treatment, so accordingly we put them back in the oven we had built, and built another fire. When they had cooled off the second time we found that they had grown just as much as the first, but were still just a trifle under the diameter wanted, so we tried it again. The third time they came out fine and I saw them after they had been machined and they turned out great. 'Seeing is believing' they say and that was the way with me. After that I used the same trick to advantage on several different occasions. It just struck me that your friend may not of heard of making cast iron grow and you can tell him how it's done."

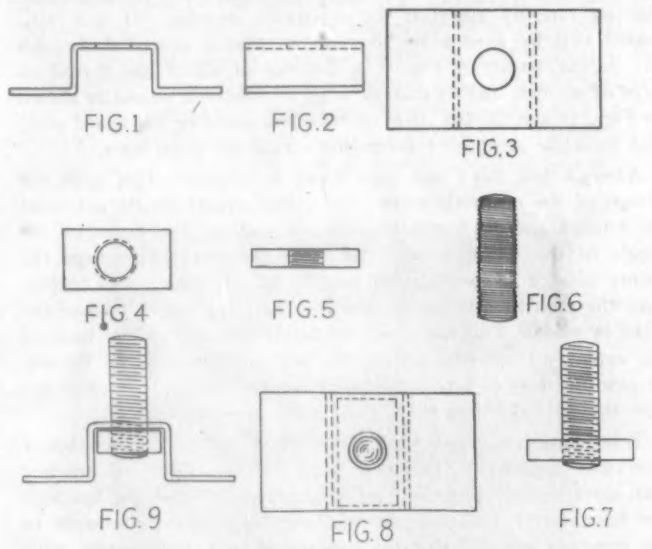
That's the dope Ed. Be sure and let me know what you think of it. I'll be back in Chicago week after next so write me there. As things stand, I was out in the rain this afternoon and got sort of a chill so its me for a good hot bath and the downy coach.

Nightie-night,
SHEP.

SPOT WELDING AIDS PRODUCTION OF BRACKETS

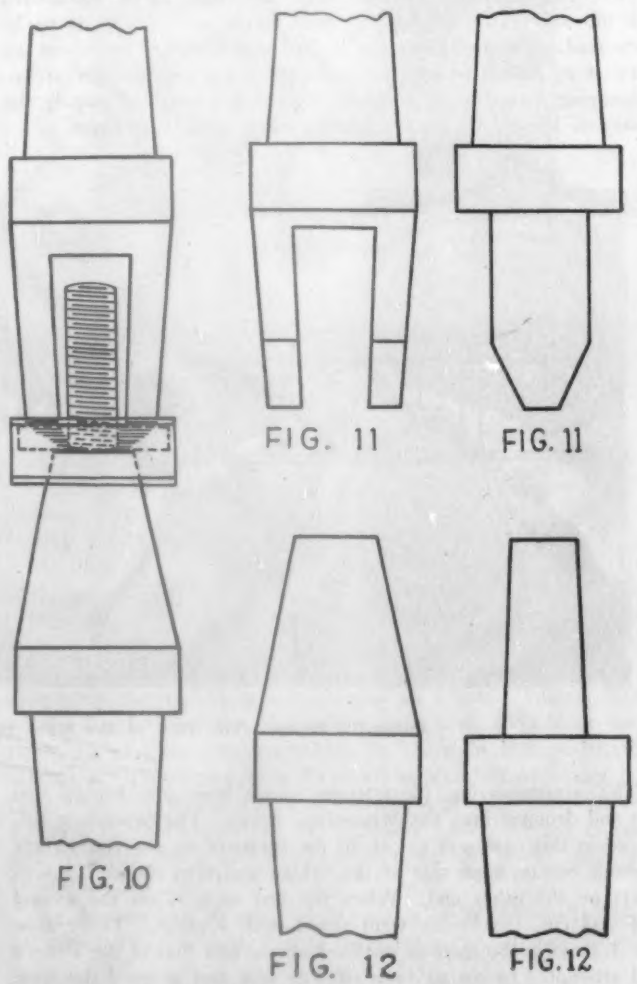
In a good many manufacturing processes it is found necessary to use a bracket similar in shape to the part shown in Fig. 9. For example, if you take a look under the running board of your automobile, you will find that it is bolted on supports in some way. The bracket support as illustrated can be made mostly from scrap metal, except the bolt which must be purchased outside unless the factory is equipped with automatic screw machines. As far as the bracket is concerned, the necessary strips can be sheared on square shears to the same width as the length of the bracket, then a die can easily be made to form and pierce it in one operation, as the stock used is usually 14 or 16 gauge metal. The lug shown in Fig. 4 is blanked from 3/16 in. scrap to the desired size, then pierced and tapped. The bolt shown in Fig. 6 is assembled into the lug, and this assembly is in turn assembled into the bracket as shown in Fig. 1.

One manufacturer had been welding his automobile for a long time with the oxy-acetylene torch. The process was very satisfactory as far as results were concerned, but the manager was anxious to speed up production if possible. The gas welding procedure had been to assemble the stud to the lug, so that the end of the bolt would be with the bottom side of the lug. A



Details of the Assembly.

cast iron table containing 200 or 300 holes was provided to receive the bolts. The assemblies were placed in these holes with the bolt etxending downward and then the welding was done



How Special Welded Points were Designed.

at the rate of 300 an hour. This assembly in turn was assembled into the bracket as shown in Fig. 9 and tack welded with one tack in each end at about the same rate of speed. Production

figures on this show that it took four men to finish 300 brackets in an hour, and although the quality of the welding was excellent, the fact that a spot welding machine was available for additional duty lead the management to attempt an increased production rate by applying the resistance process. It was estimated that by assembling the bolt so that it extended through the lug as shown in Fig. 7, a distance of about one thread or 1/16 of an inch, and by making a set of electrode points as shown in Figs. 11 and 12, the labor of two men could be dispensed with, and the same number of assemblies completed in an hour.

After a few days had been spent in experimenting with the design of the electrode points, the manufacturer finally got what he wanted and perfected the details such as the taper of the inside of the upper points, and the right distance between the points (for ¼ in. bolt should be 7/16 of an inch), so as to prevent the molten metal from climbing up from the bolt when the weld is made. The taper, or the larger opening at the base of the upper, will prevent hitting the bolt and turning the threads in case the bolt in moving should accidently tilt to one side before the welded points get a good hold on them.

This change in procedure has worked out in practice better than was expected. One man does the assembly and another man does the welding, and an average of 500 finished brackets per hour, which is being obtained now, is so good compared to the previous practice that the time spent in experimenting with the new method seems to be very well justified.

CUTTING DOWN A STEEL BRIDGE

The oxy-acetylene cutting torch has come to be recognized as the universal tool for cutting when a steel bridge is to be removed. The metal in structural steel members is just about the easiest of metals to cut, but there are a few problems of an engineering nature to be considered, so it is advisable to study the ways of these jobs very carefully before making any cuts.

Cutting a Bridge. The View at the Right Shows How Cleanly the Severed Members Fell.

The accompanying illustrations show how one bridge was cut and dropped into the Mississippi River. The procedure followed in this case was to cut all the supports on one end, except a small one on each side of the bridge and then cut all the supports on the other end. When the last support on the second end was cut, the bridge went down with a crash. The reason for following the method outlined above was that if the cutters had attempted to cut all four sides at once and dropped the span straight down, several cutters might have finished ahead of the others and the span might twist and cause an accident. In this case the span had dropped exactly as had been planned, and did not give us any trouble at all. The span was later cut in small pieces and parts of it were saved, although quite a lot was sold for junk. A wrecking crew can make considerable use of the tremendous weight of a structure of this kind if the situation is studied carefully enough to provide a method of handling the job so that there will at no time be any danger of accidents to workmen

WELDING A COAL CRUSHER CASTING

By C. M. Belcher

THIS type of steel casting is usually easy enough to weld, but the handling of it involves some difficulties, the solution of which may be valuable to those working on steel castings of a similar nature.

We recently welded one of this type which weighed 900 lbs. It had four lugs 5 in. square and 18 in. long. One of the lugs was broken off close to the casting. I laid the casting on two fire bricks which were 2½ ft. long, 1½ ft. wide, and 3 ft. thick. Two of these fire bricks formed a level surface on which to lay the casting. After beveling the lug to a 45 degree angle, I placed it in its right position against the casting and preheated both parts for about an hour with a kerosene torch. After the weld was completed the lug was ¾ in. higher than the fire brick. Some of the others in the shop could not understand why the lug was raised instead of being in the same position in which I had placed it for welding, and after I had even explained the action of expansion and contraction they still did not believe that it would come back to the proper position after cooling. The casting was left to cool for an hour and one-half, then when we measured it the lug proved to be exactly the same height as the other three.

One of the suggestions made was that I should hammer the lug down to position while it was still red hot. Of course this can be done, but it is a very poor policy to hammer an acetylene weld unless it is allowed to cool and then reheated. By following the method outlined above the contraction is allowed to pull the pieces into their former position. If the lug had been hammered down there would have been a strain left in the weld. The result would be that the casting as a whole would not be so strong, and probably would not hold up so well.

NEW MILBURN BOOKLET

The Alexander-Milburn Co. of Baltimore, Md., have just issued a new twenty-six page booklet which is a miniature catalogue covering the Milburn line of welding and cutting equipment, ranging from the smallest to a large compressing plant. The principal items in the Milburn line of apparatus and supplies are illustrated and described in detail.

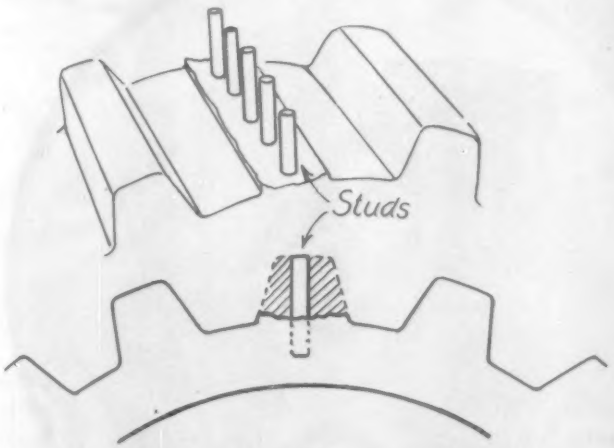
BRAZING IN A REPAIR SHOP

By R. J. Liechte

Some metals such as cast iron and cast steel, under certain conditions, are weakened if brought up to a welding heat. Jobs such as these can be welded very easily, but they often break again near the weld. When it comes back to the welder he usually points to the weld and shows how well it held; thereby exonerating himself but not the process.

As an example of a brazing repair, which is often the proper substitute for a weld I will tell how I have built up broken gear teeth, in large and small gears which have given good service, without weakening the adjoining teeth; with steel studs and a good drawn bronze.

Select a tap drill that is slightly smaller than the base of the tooth and drill and tap holes about three times as deep



Using Bronze to Renew Gear Teeth.

and two-thirds as far apart as the drill is wide. Screw in the studs to the height of the tooth. Clean thoroughly and heat to a medium red heat, taking care not to overheat the studs or adjoining teeth. If the job is to be milled the whole section between the good teeth can be filled in solid. If it is to be finished by hand, carbon blocks cut as near the shape of the tooth as possible should be used. Be sure the brass is thoroughly fused to the casting as well as the pieces and cool slowly but not as slow as a weld. When cool grind or file the top and ends to their proper size and lay the tooth out on both ends with dividers and file to the line.

An example in cast steel is the king pin holes in an auto axle that have been worn, or, if production work, drilled crooked.

See that the hole is clean, cut a piece of round iron stock about ⅛-in. shorter than the hole is deep and ⅜-in. thinner than the hole is wide; to save some of the bronze. Place the job on fire brick, seeing that it is tight around the bottom, put the plug in the center of the hole and heat to a good red heat, being sure that the plug is hot also, and fill in with bronze.

Spring pad holes can be brazed the same way.

I worked in a shop which had several hundred misdrilled axles, thrown away as scrap. After I brazed a few the rest were sent out as the piece workers kept one busy repairing machine parts.

GIBB TAKES OVER SEAMWELD LINE

The Gibb Instrument Company, of Bay City, Mich., has taken over, under exclusive license, the manufacture and sale of the automatic and semi-automatic electric are welding machines developed and heretofore manufactured by the Fred Pabst Company of Milwaukee, under their various letters patent, and have contracted to act as selling agent for the Pabst line of patented covered electrodes.

The Fred Pabst Company has spent over two years in the development of this line of equipment, and the field of application is said to be very wide, embracing the welding of tanks, range boilers, barrels, drums and tubing.

ADOLPH MESSER ON AMERICAN TOUR

For several weeks, Mr. Adolph Messer, head of Messer & Co., Frankfort Am., Germany, has been making a series of visits to oxygen plants, and other large industrial plants in the United States in the interest of the plant which he represents.

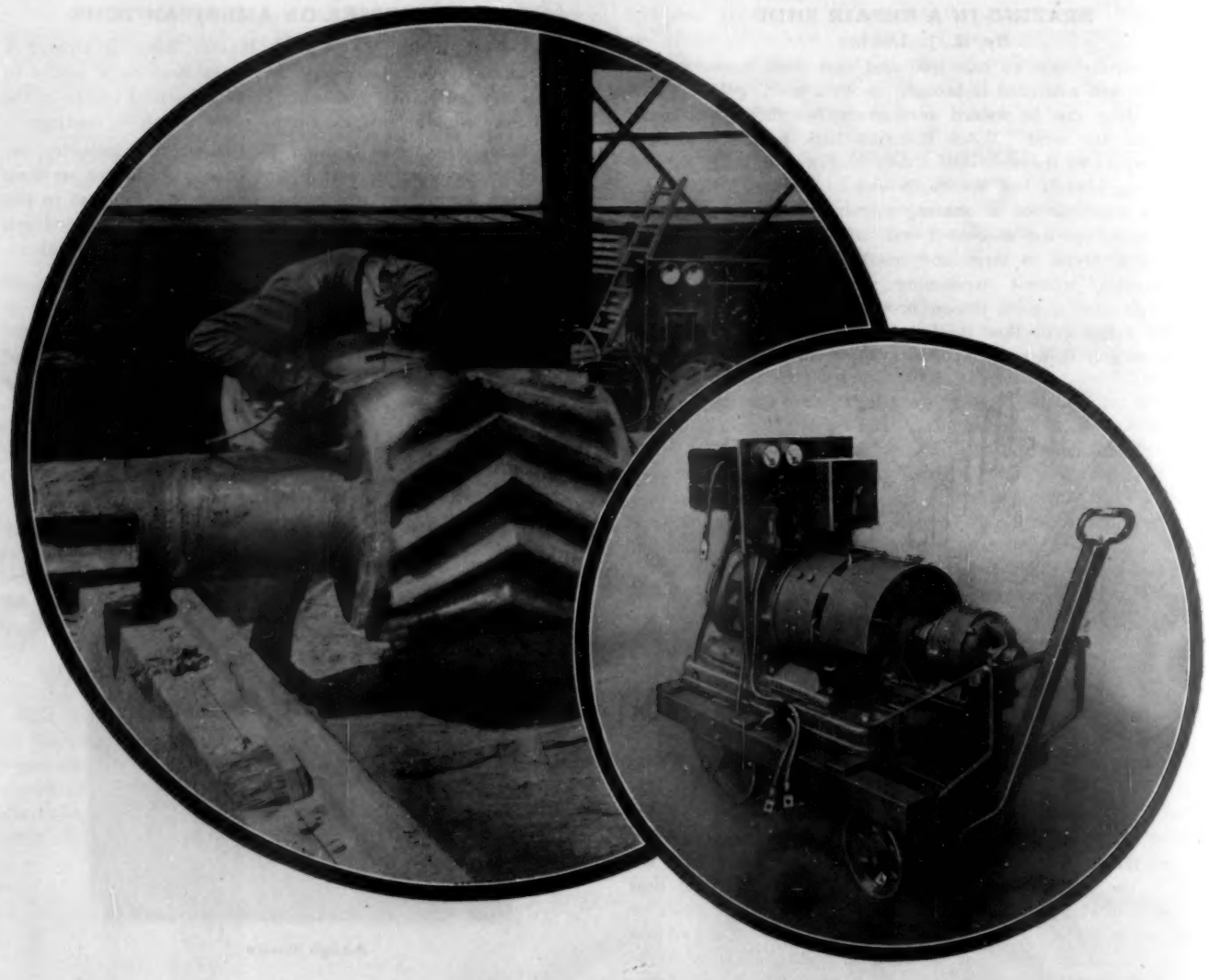
The name Messer is familiar to the welding industry because of its association with a line of oxy-acetylene welding and cutting equipment which was one of the pioneers in the industry. Before the application of acetylene to the welding process began to promise the popularity which it now enjoys,

Adolph Messer

the Messer plant was engaged in the manufacture of acetylene apparatus for lighting purposes. It was quite natural, then, that this company should have a share in the development of the oxy-acetylene process, and that recognizing the necessity for oxygen producing apparatus to furnish the oxygen necessary, it should proceed to develop the manufacture of a plant for this purpose. During the past two years a number of Messer plants for the production of oxygen through the liquefaction process have been installed in the United States by M. Keith Dunham, Chicago, so that while this latest product of the Messer plant is a comparative newcomer in the welding industry in the United States, it is no longer unknown nor untried. Mr. Messer states that the demand for such apparatus is very much greater in Germany, because that country is supplying the oxy-acetylene process on a larger scale. Some of the largest installations which have been called for were made to produce oxygen which is being used to dismantle warships. This involves a tremendous amount of heavy cutting, one installation being required to operate continuously for twenty-four hours per day in order to supply the oxygen necessary to keep 200 oxy-acetylene cutters busy for eight hours a day.

Mr. Messer can be reached in care of M. K. Dunham, 110 S. Dearborn St., Chicago, during his stay in the United States.

It is reported that the capital stock of the John A. Roebling's Sons Co., Trenton, N. J., is to be increased from $15,000,000 to $34,500,000 to provide for extensions.



Westinghouse Equipments

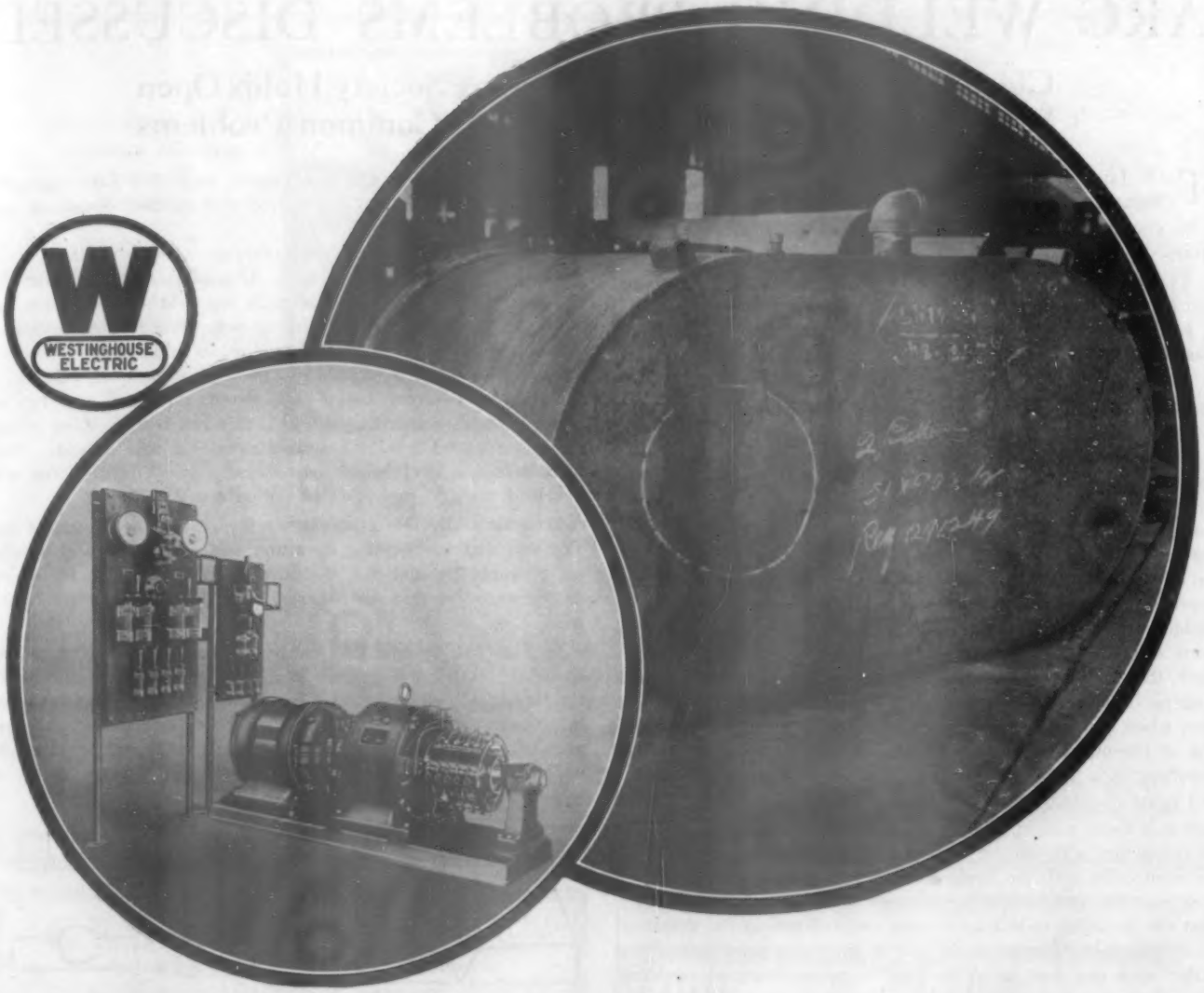
Of all the factors which enter into the making of a perfect weld, arc steadiness and arc control are of prime importance.

The idea back of the Westinghouse Equipment was to build a machine which would assist the operator in obtaining good welds consistently, and yet have a rugged simple design and construction.

The first thing done was to simplify the design as much as possible in order to secure an easy running, rugged machine to give continuous operation for steady welding work.

Second, a control system was worked out by Westinghouse Engineers, a simple, strong controller, giving the op-

Westinghouse



Assist the Operator

erator any current he may desire at the arc, or a single, steady current for a full day's work from a single rheostat. This flexibility is one of the distinct advantages of Westinghouse Welding Equipments where the Welding work is variable.

And lastly, the Westinghouse Equipments were perfected in all sizes from the popular 175 Ampere portable equipment to the heavy multiple operator equipments which have made Arc Welding such an important factor in modern production.

Westinghouse Electric and Manufacturing Co.
East Pittsburgh, Pa.
Sales Offices in all principal American Cities

Westinghouse

ARC WELDING PROBLEMS DISCUSSED

Chicago Section of American Welding Society Holds Open Meeting for Securing Information on Common Problems

THE January meeting of the American Welding Society, Chicago Section, was held Friday evening, January 12th. The program consisted of an open discussion of seven questions.

The following is a discussion of these questions, as reported by *The Welding Engineer*.

1. Under what circumstances is it advisable to preheat cast iron welds which are to be made with the electric arc?

MR. KINKEAD: Mr. Chairman, the general proposition of welding cast iron with the electric arc process is more or less a complicated one, and there are a great many ideas concerning it. I will take the carbon electrode process first because that is nearest to the ordinary gas welding method of doing the same job. Now, so far as the welding itself is concerned, there is no reason for preheating the cast iron. There is no saving in cost of heat by preheating. On the other hand, in some circumstances there is an advantage in preheating due to the shape or nature of the section. The expansion and contraction in carbon electrode electric welding is handled in identically the same manner as if the job were to be done by the oxy-acetylene flame. It is also true, however, that in the application of the carbon arc process some preheating is done in the ordinary practice with the arc itself. So that when the weld is completed there will not be a sudden chilling of the metal which has been built in in the welding process, resulting in a hard weld.

I have investigated several job shops where this work is done, and it is the exception rather than the rule that preheating is done in connection with carbon electrode electric welding of cast iron. In connection with the application of metal electrode welding to cast iron this fact should be thoroughly understood at the outset, that the so-called weld may or may not fall within the definition of a true weld. I refer to the use of steel as a welding material rather than cast iron, as is the case in carbon electrode welding. But whether or not you call the joint made by the metal electrode process in cast iron a weld or merely a mechanical joint, the facts in connection with preheating are of interest. There is very little preheating ever done in connection with the application of the metal electrode process to the welding of cast iron. In fact, the principal advantage in the use of the metal electrode process lies in the fact that it is not necessary to preheat. The steel from the steel welding rod is deposited on the cast iron and for the most part is fused to the cast iron. The principal element of strength lies in the use of the steel studs. The interlocking of the built-in material with the studs forms a mechanical joint, and it is not of particular consequence whether or not a fusion between the steel deposit and the cast iron of the original piece is perfect or not. In addition to the stud, there is a holding power to such a joint, due to the fact that as the arc progresses along the weld, depositing a steel bead, a sort of furrow is dug out in the cast iron. A series of these furrows adds to the strength of the joint. Now, as I said before, the principal advantage in the application of the metal electrode process and depositing steel lies in the fact that preheating is not necessary. In fact, the practice is to distribute the heat very widely on the piece, so that no particular area in the weld is heated to such a temperature as to cause sufficient expansion that the resultant contraction will later cause failure in the joint.

Now, it has been claimed that if a joint made in this fashion, by the use of the metal electrode process, is annealed after the welding is completed that, it may be machined. I have had no personal experience along those lines and I can't vouch for the statement. I don't see any reason why it would not be true. But there is no particular advantage in doing the job in this manner if it is later to be annealed.

In covering the matter in a general way, if I have suggested anything in opening up the subject for further discussion, the purpose is accomplished.

MR. BAILEY: We do considerable welding of tank work, arc welding on heavy plate steel. One-quarter inch is about the thinnest plates we use. Occasionally we weld some cast iron out there when we break a machine or something. This welding is done with the ordinary metal arc, for our welders don't seem to know anything about studding. They go ahead and weld it. I have in mind a very heavy casting welded in that way two or three years ago, a drill press foot, that has been working along, doing very good work. I always wondered why it held. They also welded a steel handle on to cast iron. The cast iron will break off back of the weld, but the weld will hold.

MR. KINKEAD: I would say the reason the pieces did not fail was that the welding operation was carried on very slowly, as it should be, and that the furrows created by the movement of the arc were responsible largely for the holding power of the job.

In Figure 1, assume that the bevel is all filled in with welded material. After the weld is completed it looks something like the sketch. Now, let us cut a section across the middle, as shown by the straight line. It has been my experience that the appearance of that section would be something like Figure 2. It would not make much difference whether you had very secure fusion or

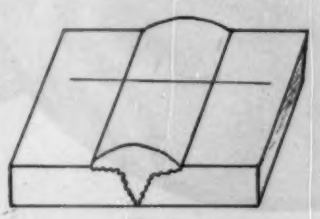


Fig. 1

Fig. 2

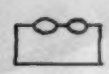


Fig. 3

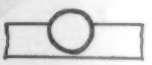


Fig. 4

not. If you attempted to pull this apart you would have to pull out this sawtooth bead here before anything would give, and I believe that the successful welding that has been done without the use of studs is due to those sawtooth beads. When you lay down a bead here you penetrate, as Figure 3 shows, and if you lay down another bead you penetrate in two adjoining areas. That is what makes a sawtooth bead. To be successful at that kind of operation the job must be done very slowly, upon a very clean surface. Of course, this job, if it had been welded on both sides as indicated by the dotted line in Figure 2, would be much better, because here we have virtually a clamp over a rough surface and considerable stress is required to pull the pieces apart, regardless of any fusion whatever. Of course, steel does fuse to cast iron. There is a very distinct line of fusion. The line of fusion is also very brittle, and in most cases can be broken. But this combination, illustrated in the sketch, is pretty hard to break, that is, by any ordinary stress that will be applied.

Now, what is true of heavy sections does not appear to be true of light sections. For instance, you can take two pieces of $\frac{3}{16}$-inch cast iron, fuse with a steel electrode, make a job as shown in Figure 4, take the piece and throw it up in the air and let it drop on the floor. It does not break in the weld. It will break clear away from the weld, where there has been no heating whatever. You can't trace the fracture to any heating effect due to the weld. The condition you get on the thin section is something entirely different from the condition you get here. The tendency here, where layer upon layer is built to make the weld, is for the heating effect to break that line of fusion, and therein lies the skill of making a cast iron weld with the metal electrode process.

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LEKTROX SWEDOX
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ARC CARBOX

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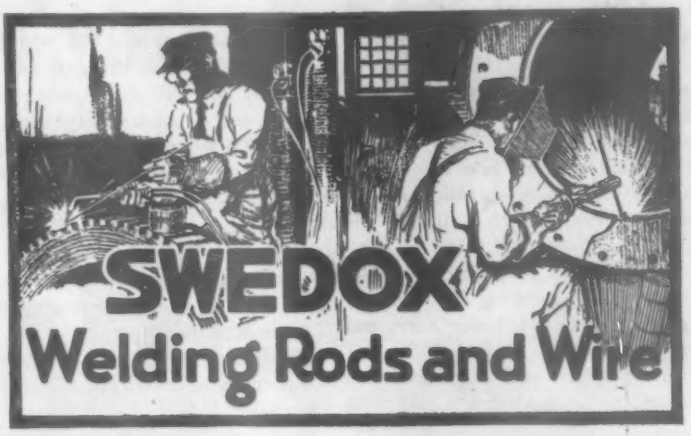

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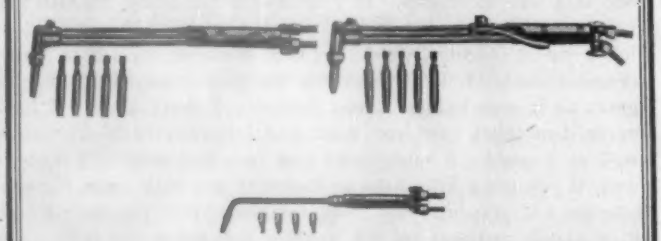

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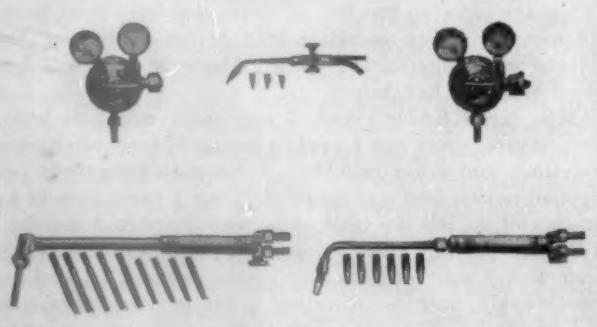

MR. WOLFF: I wonder whether this assumption is correct. In order to get a good weld with the metal electrode on cast iron you ought to weld it slowly. You would want to weld the first layer of metal deposited quite slowly, to get heat penetration, and the balance, the upper layers would be placed on just as you ordinarily weld steel to steel?

MR. KINKEAD: I believe that you get into difficulty on that scheme, for the reason that you would pull the first layer away from the cast iron. You have to do the whole operation slowly. Otherwise, you get the contraction effect, which will pull the steel away from the cast iron.

MR. HERBSTER: We have a few cast iron pieces to weld, and while I am not familiar with electric welding, I would like to know what they mean by slow welding, what size wire, and how many amperes to use in a piece about ½x2 inches.

MR. KINKEAD: I would use ⅛-inch rod and about 140 amperes. If it were a short length, to be welded, I would weld about 3 minutes, then rest about 5, and jump from one spot over to another to distribute the heat over the welded section. That would be the practice I would recommend for that job. If anything, the intermittency of the operation should be greater rather than the figures I gave.

MR. STONER: I have never done a whole lot of arc welding on cast iron. I have always found I could get better results taking a ¼-inch rod, 200 amperes, get right down on it, get it good and hot. It will flow together and weld in very deeply, but the job will be hard, quite naturally so. If you take it too slow the heat will simply fuse the cast iron and lay on it. You can take a chisel and chip off a furrow. If you take a few more amperes, smaller wire, and weld that, not lay it on, get it hot enough for the steel and cast iron to mix up together, it will stay on all right, but after it gets cold you have no place to take care of your contraction. It will check. I have talked with fellows that say they weld up automobile cylinders with metallic arc and I say maybe you did, but I never did it. I never found a cast iron metallic arc weld that would hold. I don't want you to think I am knocking it because I am not, but I never did see one that was successful. If you have a big heavy cylinder that you want fixed up and stud it you get a pretty decent kind of joint, but it is not a weld. As Mr. Kinkead says, it is a mechanical joint. I don't think the strength is anywhere near as great as it was before it was broken. I don't know. I have never done much cast iron work and I have tried to do that as well as I could. I have found cast iron and steel will do very well, if you put a little heat on it, and if you have room for contraction. If you have not room for contraction you have to put it on slowly and you are not welding, you are laying it on.

MR. JONES: I have never seen a cast iron job welded in my life, that was any kind of a success, if it was welded fast with a lot of heat used. I have not been able to do it and I have, five or six men tackling it. My biggest job is to go around and tell them: "Harry, for the love of Mike, go slow. Watch that heat. When you can't hold your hand on it, get off of it and take a walk some place." That is my trouble in cast iron welding, and we have some jobs that we think are real jobs. We have some jobs on steam separators regarding which the Crane people said, "Throw them away, scrap them." They are carrying 200 lbs. of steam and have been in service 18 months. They wouldn't hold before they were welded. Maybe it is a mechanical joint. Whatever it is, it is a better joint than we had before.

MR. KINKEAD: Well, I suppose I might as well confess, several years ago I used to get up in front of engineering meetings and prove conclusively the metal electrode process applied to cast iron was no good. Then I came over to a local shop, and, to tell the truth, I learned more in 3 months than I had learned in 3 years prior to that time, about welding cast iron, and I was convinced by results, although I had proven conclusively from a theoretical point of view, that it could not be done. The only way that a man can be convinced is to see the results, as Mr. Jones has stated. One of the great arguments has always hinged around whether or not such a job was a weld. Now, so far as I know, Mr. Jones's boss doesn't care a rap whether it is a weld or a mechanical joint, if it stands the gaff and does the job. They're satisfied. And if you will gauge this process on that basis I believe that you can be shown very successful results, indeed.

2. To what extent is brazing by the electric arc practicable?

MR. GAFFNEY: Some time ago I welded a bucket wheel in Trenton, N. J., a manganese bronze wheel. That job was successful. I welded other jobs successfully, too. I used a phosphor bronze electrode.

MR. STONER: There was an article in one of the issues of *The Welding Engineer* quite a while ago, telling how some welding shop in the West, I believe in Washington, had repaired a water-power turbine head. It had become worn in one of the joints, or where it fitted in closely around the housing, if I am not mistaken. They built a half-inch of brass under the edge of this head with, I believe, the carbon arc process, and machined it down afterward, and the job was said to be very successful.

MR. KINKEAD: I would like to cite two jobs in this connection that I personally am familiar with. One of them is the propeller shaft sleeve on ocean-going vessels, where the propeller shaft goes through the stern frame. It is customary to provide a bronze sleeve, and these sleeves wear, and they are built up by the electric process in the Eastrn shipyards, using a phosphor welding rod, **usually with reversed polarity.** Another job which we do in our own factory is the welding of short circuiting rings on induction motors rotors. Now, in that case, if you are familiar with induction motor construction, the conductors are ¼-inch diameter, copper or brass rods. They are put through the roller, and then short-circuiting rings are pressed onto the ends of the rods. Now, the carbon arc is run over those short-circuiting rings, which are made of brass, and a very excellent weld is accomplished.

3. How do you estimate the time required to make an electric arc weld?

MR. KINKEAD: I believe there is a good bit of guess work in estimating how long it takes to make an electric weld. There is not a great deal of guess work, however, in knowing how much metal can be deposited per hour of operation of the arc. But only kind Providence knows how many hours out of the day you can operate the arc. If you can fix that figure, estimate it or guess at it, you can approximate the number of hours required to complete a given job. We know, for instance, that there are about 3½ cu. in. of steel to a pound of metal. We know that with 140 ampere or 150 ampere arc the operator working as steadily as an operator can work will deposit around 2½ pounds of metal per hour, and he will earn his money at that rate. Now, on the other hand, with a 250 ampere arc and ¼-inch rod it is possible to deposit 6 pounds of metal per hour. That sort of work, however, is on steel, not on cast iron. A pound an hour is a pretty good guess on cast iron. On the other hand, if a man is depositing his metal with the carbon arc process he may deposit as high as 12 pounds an hour. But you must know what other factors enter into it. Those are factors based only upon the ability of certain number of B.T.U.'s to melt a certain amount of metal in a certain length of time.

MR. HERBSTER: That is quite a vital subject with the railroads, especially the car department, who repair parts on a car and must bill the owner of the car. Now, just about two years ago I opened that subject with our officials, when we commenced to arc weld, and didn't seem to get anywhere. They could not tell me what to charge. I knew I had to charge, but they couldn't tell me what to charge, so I finally suggested to our Electric Department to install a meter. They corresponded for a while with the experts, and that was not thought advisable, because you could not go by the reading. So they finally adopted an arbitrary figure. I don't just

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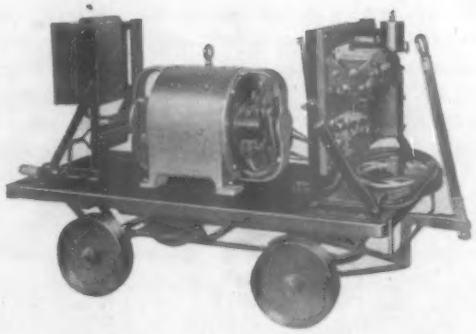

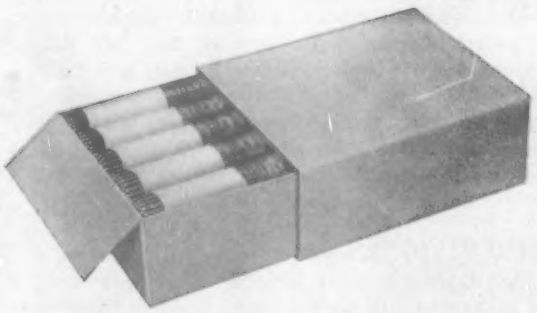

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remember it now; but I would like some more information on that subject, because it is a vital one to the railroads.

MR. MITCHELL: There are two factors that enter into estimating the time required to make a weld. One is, say, a production job. That can be estimated very accurately. The other is a job in a job shop. The average job that would come into a shop may be all the way from an automobile frame to a 60-inch high pressure cylinder on a steam engine. There is only one way to estimate that, and that is experience.

MR. KINKEAD: I have been burned often enough in estimating to believe that is about right, but the variable factor which depends upon the circumstances other than the mere depositation of metal in the job shop is the important factor. In production work, as Mr. Mitchell says, those factors can be reduced to a rather high degree of accuracy, so that the prodution of the average man, knowing the current, the size of the electrode, and the piece he is working on, can be determined, so that you know what to expect. But on job welding, there are a lot of things that enter into it besides that.

Here is a rather interesting bit of data in connection with the metal electrode process, with ⅛-inch wire, manual operation we can put on around 1¾ pounds per hour, using say, 110 to 115 amperes. I am told by Mr. Noble, of the General Electric Company, that on their automatic metal electrode machine, with ⅛-inch rod and current as high as 200 amperes, they deposit as much as 4¾ pounds of metal per hour. Now, from a purely theoretical consideration you would expect something as follows: assume that the current for manual operation is 100 amperes, and the current for automatic operation is 200 amperes, the ratio of pounds of metal deposited per hour should be as one is to four, because the amount of heat is proportional to the square of the current rather than to the first power. Since you have doubled the current you would expect four times the metal. Now, the data Mr. Noble gave me, there is no doubt based on test. I would expect slightly more metal than they show by test, but it is remarkable that so large an amount of metal is deposited with such small rod.

4. What is the quickest method of training arc welders?

MR. JONES: We have a little system of our own that I don't believe my friends in the job shop will agree with me on. In the first place, I don't believe that it is possible for any human being to start in the morning and hold an arc 8 or 9 or 10 hours. Therefore, my system is to have three operators for every two machines, and we are getting away wonderfully. Our boys are keeping the machines going and have a pretty good feeling among them. We get two good operators and one bad one and put them in there, and the first thing you know the bad one is as good as the good ones.

That is our system of training operators. I have heard men say you should find the man the difficult jobs and let him go after them. I don't agree with them. I don't like to take the heart out of a fellow at a jump. I like to give them something simple. I know the first time the boss put me on a job, and put the handle in my hand, I thought—"I don't want any of this." He got tired of looking at me and said "Here is the machine. You can stay all Saturday afternoon if you want to." By the time Saturday afternoon, 4 o'clock, came around, I got so I could go a little bit. I like to put the boys on a job that doesn't amount to so much and get them started and go away and leave them alone. I have not had a failure yet. I have a picture of two of our last students' jobs. Neither one of these boys have had more than 6 months' experience. I showed it to some of the gentlemen here tonight and they agreed it was a pretty nice job.

I was going to answer this gentleman's question on cost of operation, but I got afraid to answer him, because we make our own power, and we figure is costs 70c a day for power to operate a 200 amp. machine.

You can make a welder out of any mechanic, anybody that has any mechanical ideas, if you have patience and you can get the fellow believing as you do. Some of you won't believe that, but they will come around after a while. I thought my instructor was awful when he first started preaching to me, but the further I got into it the more I thought he knew about it, and I hope some day when our fellows get through with me and start out with somebody else they will think the same about me.

We have three men to two machines. That gives the man a chance to walk around the shop and straighten up his back. It is mighty tiresome to sit in one position all day. Mr. Kinkead told me when I started in the game "Be sure you make the man comfortable," but I never did find that position. Our company has not found any fault yet. I don't think they will. The machines are going every minute of the day that the boys are getting paid for, and we have always a couple of extras to keep the machines going if one of the boys is sick or off.

MR. HERBSTER: Mr. Jones's remarks bring to mind a little incident that happened to our welder, who is right here. We have been accustomed to making steel tanks for holding oil, and they have been made by the tinner until this year. We asked the tinner to shape the forms and we took them to the welding shop. Our welder said "I don't know as I can do that." I told him I expected him to spoil the first one, to go to it. I let him alone. I don't know a thing about welding. He does. He went through with it in very good shape, a whole lot better than I or my superiors expected, but he made the job, and he is still at it, at the second one now. I think the only way to do is to put them on the job and let them run it.

MR. GUSTAFSON: This tank we are speaking of is 16 gauge, and I have a 200 ampere machine. I thought it was pretty hard to reduce this low enough to weld that sized metal. But I found out a way to put on more resistance and I seem to be getting a good weld. I am penetrating through in a few places, but I think I have found a way out of that, by putting a heavy piece of steel underneath, which seems to take the extra heat away.

5. What is the cost per hour of operating a motor truck outfit?

MR. OWENS: Mr. Chairman, about 8 months ago I was asked to take care of the demonstration truck. The way we figured out the cost per hour was that the outfit itself would come to about $1600, the truck to about $1800, and wire and accessories about $200. They put me on the road and I did not have anything in view but go ahead and find something to do. This happened to be in Dubuque, Iowa. I went towards Omaha and at each town I went into each garage and each blacksmith shop to do demonstration. My cost the first week was about $75, including my expenses in operating the truck. After I learned to save gas and time the average cost of the whole trip was about $45 or $50 per week, demonstrating. That is the only experience I have had so far.

MR. KINKEAD: Along this line, since this is more or less an important element of job shop practice, I might point out in connection with what Mr. Owens said, that the job shop is up against somewhat a more serious problem than he was up against in a demonstrating outfit. In the first place, I would hardly say, the outfit would be complete for commercial work, for the reason that a job shop does a considerable amount of boiler work, and therefore must have in addition to the equipment Mr. Owens mentioned, some means of producing compressed air, and the means usually employed is to have an engine-driven air compressor in addition to the welder. That necessitates a considerable amount of additional weight to the total equipment which in turn necessitates a larger truck. Then, to do the general run of jobs it is advisable, at any rate, to have at least a double line, a total of 800 feet of welding cable and of course 400 feet of air hose, and the outfit is not complete without an oxy-actylene cutting outfit. There are a number of minor accessories that are also required. Now, that truck may be operated by one man. As a rule, however, it is more economical to have two men, for the reason that in setting up the equipment for the job two men can work better than one, and by having one man at the truck while the job is being done it is often possible to avoid serious difficulties so far as the engine is concerned. It is a pretty good idea to have a man on the job watching that engine while it is in operation. Now, the matter of insurance, license, etc., for the truck amounts to a considerable figure; liability and workman's compensation insurance on the men who operate that truck is an important item. The depreciation and maintenance of the truck and of the welding outfit and of the air compressor are all considerable items. So that a general average of $50 a week for the operation of the outfit, in my humble opinion, is probably low by $125 or $150 a week. The job welder who operates such an equipment must keep the equipment busy a considerable portion of the total working hours in a week, and as Mr. Jones says, at a pretty substantial figure per hour. Since that equipment is used largely for emergency welding purposes, its operation factor, and by that I mean the number of hours out of the week that it can be operated on productive jobs, is not as large as you might think. But the men draw their pay whether the outfit works or not. So that there are a good many items of expense to be considered in the commercial operation of a motor truck outfit which would not ordinarily be considered in merely a demonstrating outfit.

6. What are some of the tests which can be made to demonstrate the value of arc welding without the use of laboratory facilities or scientific instruments?

An experience was brought to my attention a little while ago along this line. A man conducting a welding shop dropped into the office one day and opened up a little portfolio. When he opened it, I saw five pieces of nickel-plated metal sticking out from the little pockets. He told me that those pieces of metal were respectively steel, cast iron, copper, aluminum and brass. The pieces were nickel plated, so I could not very well pick them out. He drew the pieces of metal out of the pocket about ¼ inch and said, "Now, can you pick them out?" Of course, it was not much of a job, because the nickel plating did not extend over the area he exposed. He told me these pieces had all been welded and asked me to pick out the welds. I looked at them pretty sharply, and there was only one weld in the five pieces that I could pick out. He had done an excellent job of welding. Then he pulled the pieces out another ¼ inch and showed the rough weld. Finally he pulled it out all the way and showed the method of preparation he had used. It had been welded longitudinally, and he was using this little portfolio to answer the question which arose when he was soliciting business, "Can you weld aluminum? How well can you weld it?" I think that all of you appreciate the thoroughness with which he could answer the question when he could pull out those little samples and show them. That was just a visual test as to whether or not those metals could be welded, and incidentally, the welds were made with a torch.

MR. BAILEY: We had the problem of welding tank bottoms on a large field oil tank, about 117 feet in diameter, approximately 3,000 feet of welding. The reason we were so sceptical is that we only weld with the pieces on the ground. You don't get a chance to test it. You can't fix it after you put oil in it. The big field tank is done in a rough sort of way in the field. We were wondering how many leaks would show up in 3,000 feet. The oil pressure is about 40 feet. The test we made consisted of welding a tank of ⅛-inch plates, about 3 feet long, designed very roughly as shown in the sketch. At 16 pounds pressure one slight seam developed. We gradually worked up to about 25 or 30 pounds. At 30 pounds the tank burst, which would be, on the gross section of the plate, equivalent to about 33,000 pounds per square inch stress on the plate, or about the yielding point of the steel. The weld was simply the lapping of ⅛-inch plates with one strip across it. That was all we dared

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to put on. It is more or less of a speed job, and must be tight. We also intend to make another test of a different machine, when the tanks are finally welded. At present they are riveting them. When they are finally welded we hope to do it by welding them on the ground.

I would like to know, with ⅜ and ¼-inch plates overlapped, lying on the ground, somewhat buckled, what reasonable speed we can expect and the cost of it. We have tried it on a tank roof of the same diameter. We know something about that.

MR. KINKEAD: One of the difficulties—I am using experiences we have had with the electric arc process—arises from the belief in the minds of a good many machinists that there are certain conditions as to voltage and composition of the welding rod that cause hard spots in the weld, and we are frequently called on to explain the situation as to what causes the hard spots. One fellow will say, "The voltage you are using is too high." Whenever you use an open circuit voltage he will say that 90 volts makes the metal hard. So what we do in that case is to make a weld with, say, 50 volts, open circuit, and make another weld right along side of it with the high voltage, and put up an offer of $5 to the operator who can make one of them hard. That is usually a rather convincing test to show that the open circuit voltage in the machine has nothing to do with the hardness of the material.

Another question that is raised in regard to welding rods, one rod may have no carbon in it, another rod may have as high as .15 per cent. Naturally the machinist thinks the rod having the highest carbon will produce the hardest weld. So we repeat the weld to show there is no difference in hardness due to such a small difference in carbon content.

I might say in passing that the cause of hardness, where such a low carbon steel rod is used, lies in the presence of scale which has been enfolded in the material, and is a thing which only the operator can avoid. Some work has been done along the line of the application of electric welding to structural steel. The General Electric Company and the Electric Welding Company of America have welded the trusses, roof trusses of small buildings, and applied every rough test they could think of to the welded sections to determine their fitness for the job. In one case I remember a picture in *The Welding Engineer* of a roof truss that was covered with men who were standing up on top of the truss to see if they could break it. I wondered at the time whether the men did this or not, because that would be a real test. But as times goes on and the application is extended into the field of structural steel, I believe it will be found useful to make up miniature sections of various trusses, weld them together, build them or design them according to scale, and apply the corresponding load to that section, and thus determine the fitness of the section for the job.

MR. OWENS: During my trips I ran up against blacksmiths, acetylene welders, electric welders, some of whom have had a little experience, some have had a lot. The method I used, if he was a blacksmith and said the weld was too hard, was to put it in the fire and let him bend it, cold. after it had been heated. I would let him take the sledge hammer and break it in two, and show him the fissure, the structure of the weld, convince him; then take a chisel and chip off a piece: let him do it himself. I have convinced many skeptics that way. I give them the hack saw and let them cut it in two. That is one way I have been able to convince them that the electric weld was not hard. Others say that you can't weld heavy or high-carbon steel; I'd weld it up and let them take a piece of soft steel and put the two together in the fire and let them pick it out. Invariably they have been unable to pick out the high carbon from the soft.

MR. BAILEY: I am reminded of another test of laying one large plate, about 6 feet wide, across another, piling plates across the first, and opening up in such fashion across the weld. They bent the plate more often than they broke the weld, raising it up with about 6 foot leverage, using a larg crane.

MR. MILES: I recently saw a manufacturer testing pressure vessels by submerging in a tank of water, as you would an automobile tube. If it showed no leaks it was welded. Lateral welds had been made up the side of the vessel which had a tapering, cone-shaped top. It was also welded around the bottom.

7. What is the best method of keeping a motor truck outfit busy on outside work?

MR. JAEGER: Advertise in your local paper and in papers published in the territory you expect to cover. Tell them of the efficiency of your equipment and that you have it on wheels. Respond promptly to calls regardless of whether conditions, roads permitting. Do a good job and leave the customer satisfied both as to work done and price charged. You are, of course, entitled to heavier charges for work done in the field. Your customer knows this and is willing to pay more.

The up-to-date Portable Electric Arc Welding Outfit consists of an Engine Driven Welding Generator mounted on a truck with all accessories such as hoods, face shields, cable, electrode holders, welding wire, etc. The outfit can be made more complete and efficient by adding an air compressor. This compressor can be operated by belting to engine flywheel. An Electric Driven Grinder and Electric 32-volt Drill can also be added. Current for the Grinder and Drill motors can be furnished from the generator. A set of 32-volt rubber cell storage batteries furnishes light for night work in the field. With such an outfit you have practically a Machine Shop on wheels and when once your community gets to know about it, you will forget about the problem of "How to keep a Portable Welding Outfit Busy."

Some of the welders using our machine make regular scheduled trips through their territory. One party told me recently that in working the farmer trade he finds that every farmer is good for from $10 to $50 worth of welding repairs. Parties who have tractors, separators, steam engines, road grading machines, etc., have many uses for welders during their operating season and when they want a break welded, they want the job done quickly.

To keep a portable engine driven welding outfit busy in the larger industries, such as railroads, boiler shops, oil fields, ship yards, etc., it is simply a matter of applying the engine-driven set where electric current is not available or cannot be obtained without considerable expense. Portable engine-driven welding machines in industrial plants are money makers and pay for themselves in a very short time.

On our trip we welded more than 300 jobs. The time alloted to the different jobs varied from ten minutes to a day and a half.

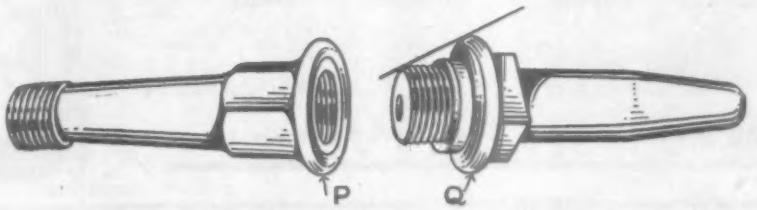
I might here state that when we started out on our trip we had no intention of charging anything for our work, but we found so much work outside of actual demonstrations, that we had to "run away" from the greater part of it in order to keep traveling our route. For these special jobs we charged a nominal fee and gathered up enough of such work to pay the traveling expenses of both the outfit and crew.

It was then clearly demonstrated that an outfit properly advertised in a territory could not only be kept busy, but also make big money.

One could write a book on the nature of the many different welding jobs encountered on this trip. It was a wonderful experience, and as an educational feature for myself, it could not be beat.

The one big feature was the interest shown by all on whom we called. They seemed to realize the fact that the industry had wonderful possibilities and that the application of the arc, while yet in its infancy, was the coming thing. In my opinion the industry needs more operators, as many of the improved methods of application, both as to electrode and metal featues, are as apt to come from the job operator in the field as from our research laboratories.

The February meeting of the Chicago Section is scheduled for Friday evening, February 2nd. The program will consist of an open discussion on the subject of training welders.



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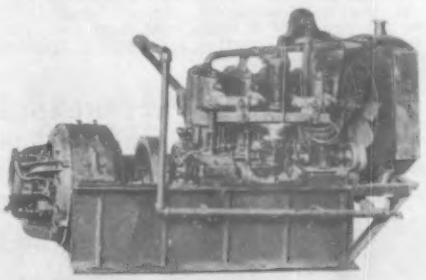

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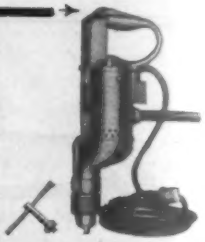

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Current Welding Literature

REPORT OF COMMITTEE ON ELECTRIC WELDING—The report gives the essential requirements of the construction of a single operator direct current arc welding generator set for use in railroad shops. The original intention of the committee was to draw up specifications for all types of arc welders, but so far there has been only time enough to apply this to single operator direct current generator sets. The report includes the rating, operating characteristics, commutation, control and safety considerations.—Railway Electrical Engineer, October, 1922.

COMMENTS ON AUTOGENOUS BOILER WELDING, by C. W. Carter, Jr.—A brief discussion of the essentials of good welding practice, including skilled operators, clean metal, proper preparation of parts, and selection of well material, followed by a description of a report on crack in a side sheet.—Railway Mechanical Engineer, November, 1922.

BUTT WELDING, by A. L. DeLeeuw—The process of upset welding. Hand and automatic machines. The preparation of parts to be welded when the pieces are of unequal cross section. Handling material which is too large for the machine. Making tee welds in tubing. Upsetting metal for subsequent machining.—American Machinist, January 11th.

SOME RECENT DEVELOPMENTS AND USES FOR RESISTANCE WELDING, by H. A. Woofter—The advantages of the resistance welding process for seam welds, spot welds and butt welds. Some of the more popular applications of this process. A general dicussion of the range of usefulness covered by each method.—Acetylene & Welding Journal, December, 1922.

THE PROTECTION OF ACETYLENE GENERATORS AGAINST FREEZING—In regious where the winter is particularly cold, the freezing of generators occasions considerable inconvenience. The general precaution against this inconvenience is, first not to place the generator in the cellar, or other close place for protection. There must be ventilation, and if freezing does occur the thawing must never be done with fire or a hot iron. Neither should an open fire be used to prevent freezing. Hot water is absolutely safe. In some cases generators are blanketed. Others use a building with a double wall. Others arrange for the device to be in continuous operation.—Journal De L'Acetylene, Paris, November, 1922.

THE USE OF OXY-ACEYLENE EQUIPMENT IN CITY GAS PLANT, by E. E. Lungren—A general discussion of the utility of gas welded joints in pipe lines to carry city gas under pressure. Great care must be exercised to select operators who are experienced, and to make them as comfortable as possible in their work. Care should also be taken in the selection of equipment.—Acetylene Journal, January, 1923.

UNDERWRITERS' LABORATORIES AND ITS RELATIONS WITH THE ACETYLENE INDUSTRY, by A. R. Small—A history of the organization and progress of the Underwriters' Laboratories, Inc. A definition of its purpose and its method of operation, explaining the significance of the label service of the Laboratories.—Laboratories' Data, November, 1922.

WELDING AS A FACTOR IN STEEL PLANT MAINTENANCE, by E. R. Norris—A development of the welding organization in the steel plant. A list of the most common jobs which are welded, with data on a variety of these repairs made, and considerable information on the cost of making the welds, as compared to the saving which is involved.—A. W. S. Journal, December, 1922.

WELDING OF STORAGE TANKS—The report of the committee for the electric welding of storage tanks. Shape and dimensions recommended for electrically welded joints, details of the designs in the joints, with diagrams showing recommended procedure for the assembly.—A. W. S. Journal, December, 1922.

STUDY OF TORCHES AND FLAMES, by R. Grajon—A discussion of torch construction which points out the common causes of flash-backs and the modern principles of torch construction which tend toward greater safety. A good many accidents can be avoided according to the author by taking care to clean the interior of the torch occasionally, but the basic remedy must be supplied by the torch manufacturers who have the problem of improving construction, so as to minimize the chance of accident.—Revue De La Soudure Autogene, Paris, November, 1922.

AUTOGENOUS WELDING APPLIED TO REPAIR OF BOILERS, by R. Granjon—A broader application of the welding processes is reached in this direction. Welding does not seem to have been completely recognized in France, although there is plenty of evidence that there are capable welders available for the work. Attention is called to the amount of this work which the inspectors allow to be done in the United States, although such work is subjected to rigid operating rules. It is recognized that the application of welding to this class of repair must be carefully regulated.—Revue De La Soudure Autogene, Paris, November, 1922.

WELDING OF FLANGED SHEET METAL—Some practical suggestions for welding sheet metal, particularly when the method of preparation used is that of flanging the abutting edges. It is found that small clamps are very serviceable for holding the parts in position for tacking. A number of common difficulties encountered in welding thin stock are described, and methods are given for avoiding them.—Revue De La Soudure Autogene, Paris, October, 1922.

RULES FOR USE OF WELDING IN UNFIRED PRESSURE VESSELS—A reproduction of a section of the preliminary A. M. S. E. report on unfired pressure vessel construction, devoted to acceptable welding practice.—The Boiler Maker, December 1922.

CARBONIZING BY MEANS OF THE ACETYLENE TORCH, by Milton Wright—Description of an ingenious arrangement for employing the heat of an oxy-acetylene torch in conjunction with a continuous jet of water, for the hardening of teeth in ring gears. The device is being used for doing this work on a production basis in the plant of a large automobile company.—American Machinist, December 14.

MECO CATALOGUE—A new catalogue and price list of the Modern Engineering Company's line of oxy-acetylene welding and cutting equipment and supplies. Tank trucks, tank stands, carbon burning torches, goggles, lead burning equipment and regulators are included. A handbook of instructions for oxy-acetylene and oxy-hydrogen cutting and carbon burning is included.—Modern Engineering Co., St. Louis, Mo.

THE LEAD BURNING TORCH, by David Baxter—A description of a lead burning torch and details of its application to the repair of lead storage batteries.—American Blacksmith, December 1922.

COAL INDUSTRY USES OXY-ACETYLENE IN YARDS—A description of the application of oxy-acetylene welding in the yards and at the docks of a large coal company, illustrating the value of standardizing of practice in applying the process.—Oxy-Acetylene Tips, November, 1922.

G. P. A. DRAWS BIG ATTENDANCE

The annual mid-winter convention of the Gas Products Association, which was held January 11th, 12th and 13th, in the Hotel Sherman, Chicago, was well attended almost to the point of breaking all previous records.

The open sessions of the convention, which were held in the morning of the 11th and 12th, furnished an opportunity for the associated members and guests to lay before the members of the Association matters which they deem to be of importance at this time. The attendance at the executive sessions was considered by all of the active members to be of unusual importanee because of new problems which the Association is facing as a result of changed conditions.

The closing feature of the convention program was an excellent banquet held at the Hotel Sherman, Saturday evening, January 13th. This was well attended by members and guests, a number of whom left on a special car the following day for New York City to attend the annual dinner of the Compressed Gas Manufacturers' Association, which was scheduled for the evening of January 15th.

The Linde Air Products Co., 30 E. 42nd St., New York, has started work on a new plant for the manufacture of oxygen at North Anthony and St. Louis Sts., New Orleans, La.

A new welding shop has been started at 326 E. Jefferson St., Springfield, Ill., by the A. V. Moore Welding Co., Alton, Ill.

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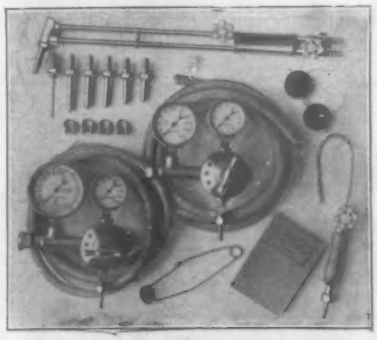

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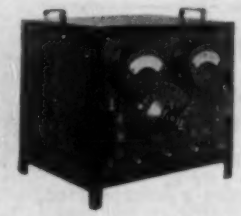

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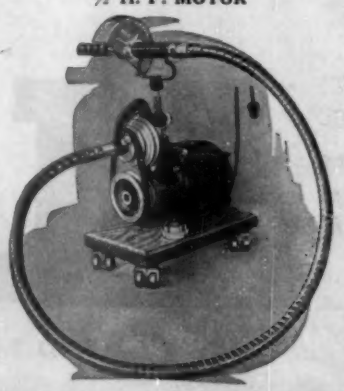

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A WELDING ROD HOLDER

For the Oxy-Acetylene Welder.

If you are selling welders' supplies, keep a few welding rod holders in stock. There is a growing demand for this handy tool. Write for Prices and Samples.

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DAVIS-BOURNONVILLE COMPANY
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The Oxyacetylene Welding and Cutting products formerly manufactured by Davis-Bournonville Co. are now made and sold by Air Reduction Sales Co. under the trade name of "Airco-Davis-Bournonville" or "Airco-D-B."

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Turn on the gas

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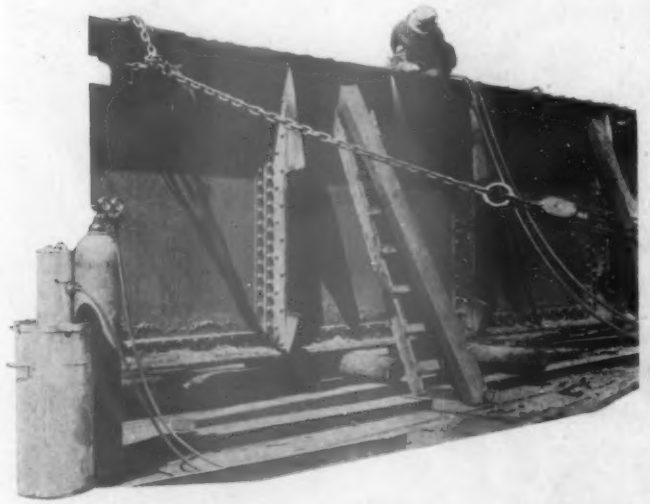

There are no weights to adjust, clock works to wind or cranks to turn,—in fact, there isn't a single intricate, complicated or troublesome part on the Carbic generator.

When you open the valve, water begins its action on the Carbic cake and a good, clean, steady flowing acetylene is immediately on tap for your use.

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Acetylene from Carbic cakes costs but half of that in tanks.

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Duluth, Minnesota

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Carbic Cakes save money, time and patience, and yield a purer gas

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The trade name Carbolite has represented our product continuously for many years. Its appearance on each package is a guarantee of its excellence and a protection to our customers.

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